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Next Month

In choosing winners of the First Annual Modern Plastics Competition, judges were placed in a difficult position by the number of remarkably practical entries they encountered. Each grouping presented its own problem because there were so many outstanding entries and so few awards to be made. Consequently, in our November issue we shall picture the entries which made judging difficult and Honorable Mention will be given those most deserving of it.

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THE FIRST MODERN PLASTICS COMPETITION

Nothing, perhaps, could indicate the length and breadth of the scope of plastic materials better than this First Modern Plastics Competition in which hundreds of examples of engineering skill and designing ingenuity are displayed for easy comparison.

The style group clearly indicates the influence these versatile materials exert upon fashion merchandise. It points the way to tremendous growth and development in coming years and is a revelation of progress achieved within a comparatively short period of time.

The decorative group—which embraces all items designed primarily for household or architectural use—clearly reflects the influence of the experienced designer and the current tempo of American life. Applications are increasingly practical and the decorative advantages of these colorful materials are deftly handled with a true appreciation of their specific values. From the humble and utilitarian ash tray to the elaborately laminated bar and lounge of the "SS. Queen Mary", this decorative group is truly representative of the forward advance these materials are making in the decorative field.

The industrial group—by far the largest in the current exhibit—embraces all the materials in their most effective form. Here you will see the definite trend of replacement of older materials with new. Housings of all sorts have taken advantage of the homogeneous nature of the materials to obtain an economical and lasting surface. Electrical devices exemplify the insulative value of the materials combined with an attractive finish, and the molders' skill shares honors with line and form given to the various entries by the designing engineers who have painstakingly created them.

The prize-winning entries in each group were not easily chosen. Judging was based not alone upon beauty or appearance, but upon the practicality of the use of a plastic for the particular job it was destined to do. First, second, and third winners, based upon the unanimous decision of the judges in each group, are pictured on the following pages, together with a brief description of the merits which prompted their selection.

Awards will be made at a presentation dinner to be held on the evening of October 29 at the exhibit rooms of the Metals and Plastics Bureau on the third floor of the International Building, Rockefeller Center, New York City, where all entries in Modern Plastics Competition will be displayed until November 22. On that date the display will be transferred to the International Society of Arts and Decoration Exhibit at Pedac Galleries in the R.C.A. Building, Rockefeller Center. Duplicates of the Winning Entries will be exhibited during this period in our own Auditorium, 425 Fourth Avenue, New York City. Our readers are especially invited to visit these exhibitions as our guests.

This trophy, which is an all plastic plaque suitably engraved, will be given to those companies whose entries won awards in the MODERN PLASTICS Competition, also, to those concerns whose material, equipment or services entered in any way into the production of the winning entries.

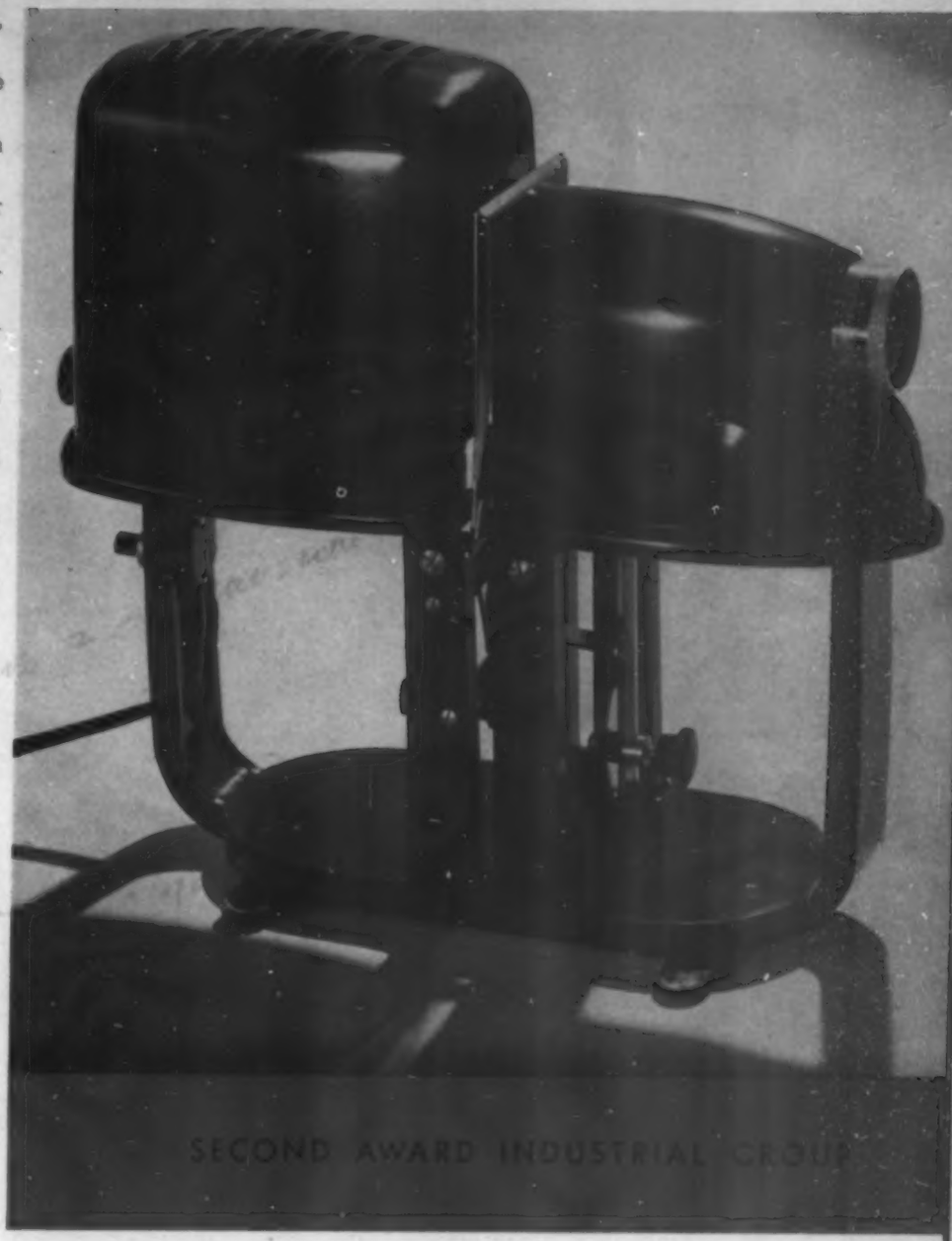
FIRST AWARD INDUSTRIAL GROUP

The Toledo Scale Company, Toledo, Ohio, wins First Prize in the Industrial Group for its Toledo Plaskon Scale. The housing, or outer casing, of the scale is molded of white Plaskon, a urea material, by The General Electric Company—Plastics Division, Fort Wayne, Ind. The material, Plaskon, was made by Plaskon Company Incorporated, Toledo, Ohio. Harold Van Doren & Associates were responsible for the design.

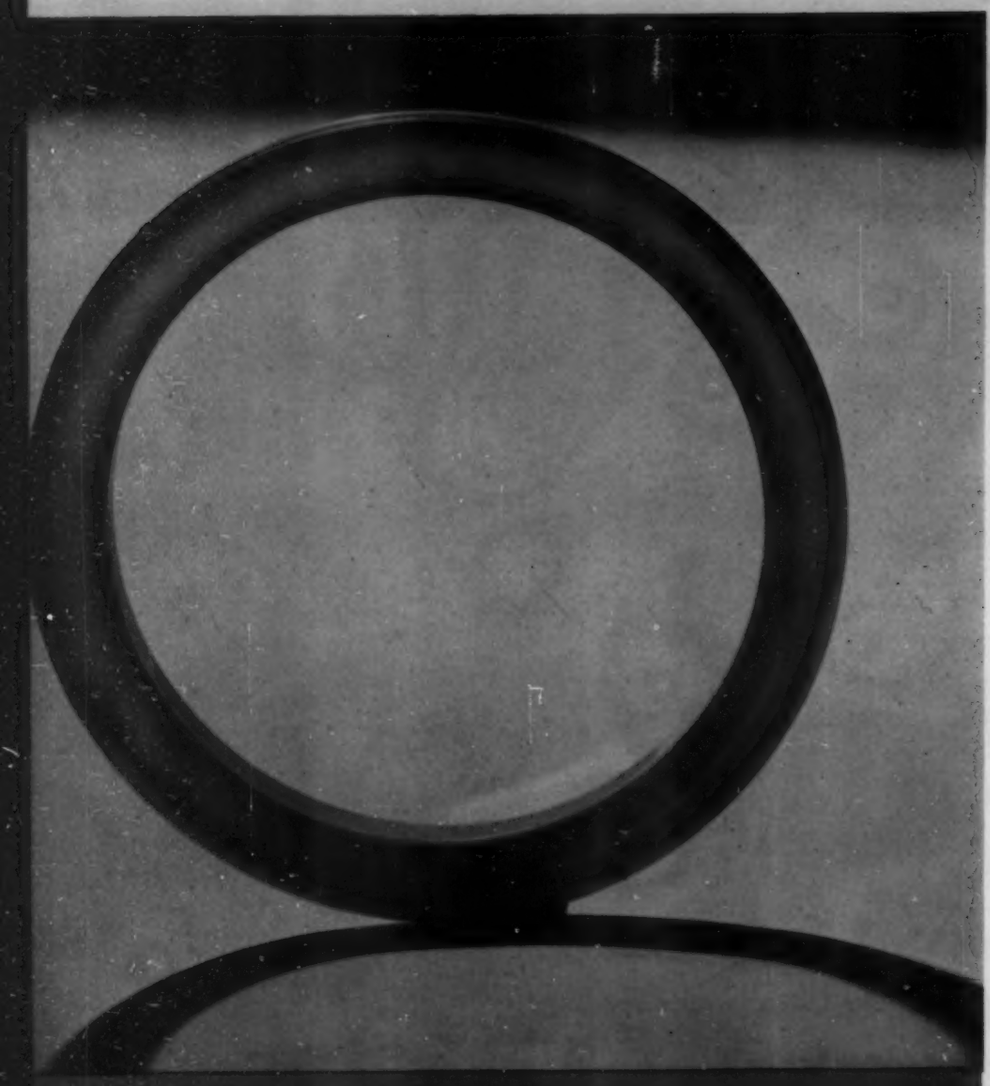
"The primary purpose of redesigning and actually remaking the Toledo Scale was to lessen its weight for greater convenience in making selling demonstrations and for improved appearance and service in the retail shop. Through the use of the Plaskon housing the weight of the scale was reduced from 165 lbs. to 55½ lbs. Large savings in shipping costs are secured. Its finish is permanent. It is infinitely smarter in appearance. And a number of manufacturing economies were accomplished through the use of this new plastic material," says H. D. Bennett, president of the Toledo Scale Co. "And best of all," he adds, "the new scale has enjoyed an exceptional increase in sales."

Burton Manufacturing Company, Chicago, Illinois, takes Second Prize in the Industrial Group with its Burton X-Ray Projector. The front and rear housing as well as the base and connecting supports of this new projector are molded of black Bakelite, a phenolic material, by Chicago Molded Products Corporation, Chicago. The material, Bakelite, was made by Bakelite Corporation, New York, N. Y., and Eugene Reinecke of Barnes and Reinecke was its designer.

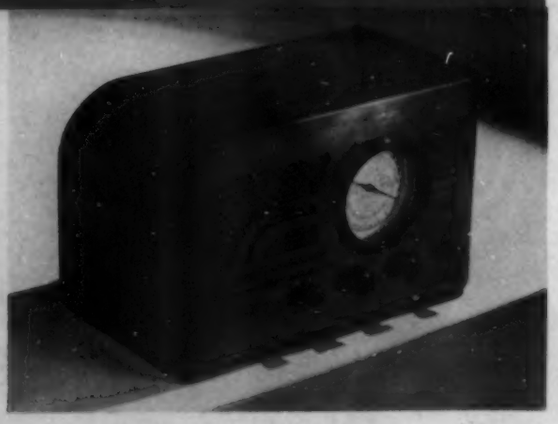
The Burton X-Ray Projector is a new and interesting application of molded plastics in the field of dental equipment. Its purpose is to project X-Ray photographs up to 50 times actual size, so patients can see clearly the condition of their teeth. Molded plastics material was chosen for the housing, not alone for its heat and electrical insulating properties, but also for the sake of appearance which is important in equipment of this kind. The design is one of simple dignity, with an air of efficiency which helps to quickly gain the confidence and personal interest of dental patients.



SECOND AWARD INDUSTRIAL GROUP



THIRD AWARD INDUSTRIAL GROUP



The Colonial Radio Corporation, Buffalo, N. Y., wins Third Prize in the Industrial Group for its novel application of cellulose acetate material which is injection molded around a glass lens by Erie Resistor Corporation, Erie, Penn. The escutcheon, or bezel, is Tenite, made by Tennessee Eastman Corporation, Kingsport, Tenn., and is molded on an Isoma injection type machine. L. Berry, an Erie Resistor Corp. engineer is responsible for the engineering design.

"Glass breakage has been reduced to a minimum both in manufacturing process and after the unit has been molded, due to the fact that cellulose acetate has a certain amount of pliability which does not place an excessive strain upon the lens such as is experienced when glass is placed in a rigid enclosure," says Mr. Berry.

The escutcheon is attached to the cabinet by means of two gates formed in the molding process. A spring-type lock unit is used to hold it in place. Assembly costs have been materially reduced by this simple means of holding the escutcheon in place over the dial it protects. No finishing is required on these parts when they come from the molds.

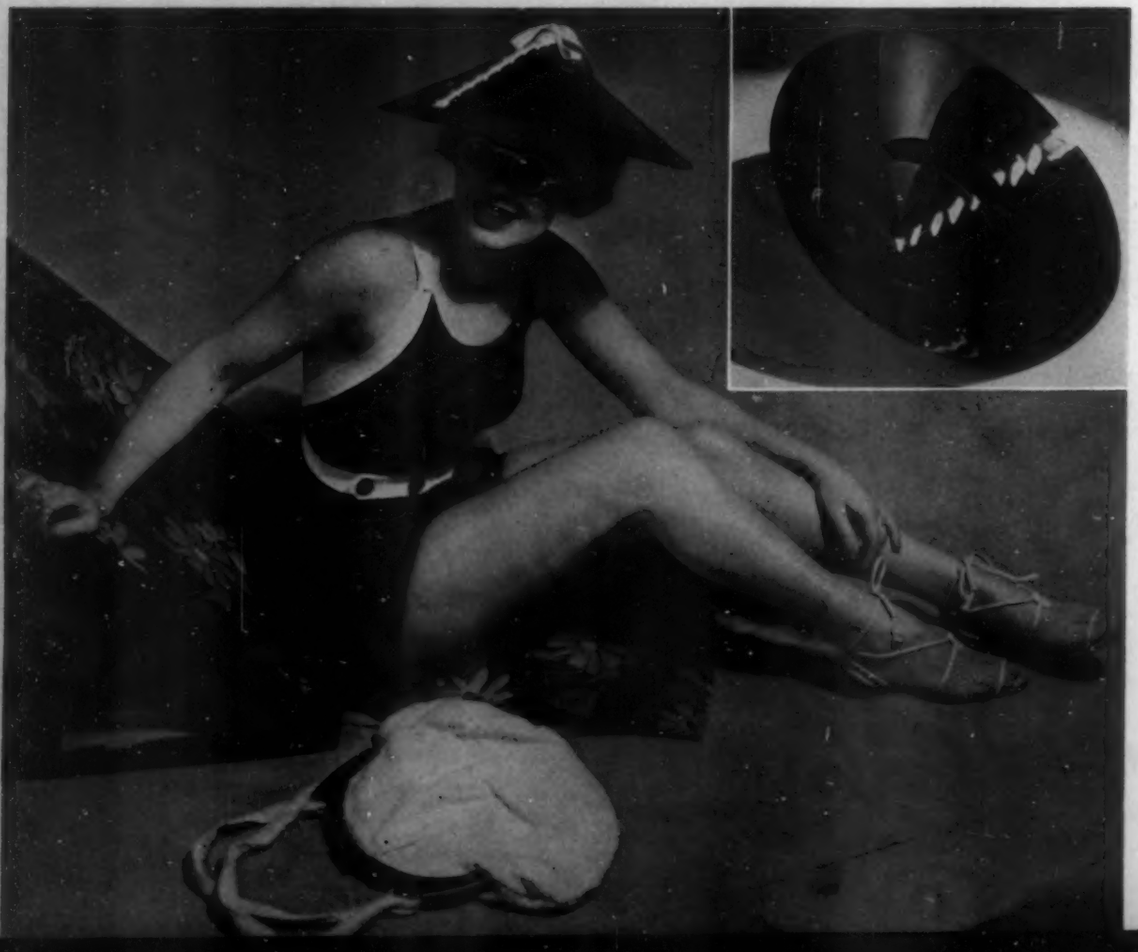
FIRST AWARD STYLE GROUP

The Revolite Corporation, New Brunswick, N. J., has been awarded First Prize in the Style Group for its exceedingly practical and strikingly smart evening wrap of quilted silver Revolite, a resin treated fabric. The material was resin coated by the Revolite Corp. with Bakelite resin and the wrap was styled by Helen Runyon of the Revolite Corp.

Revolite, because of its resinous coating, is a fully waterproofed material, resistant to chemicals and even fire-resistant to a remarkable degree. Its use in drapery fabrics and furniture coverings is well known to decorators. Many industrial uses of the material are equally familiar, but so far as we know, this is its initial appearance in evening wear and is indicative of the versatility of plastic materials. With its resinous coating which is completely invisible, the silver wrap will not tarnish. It can be washed with soap and water as required and rain, snow or sleet will have no damaging effect upon it. Resin coating is entirely without odor.

Paristyle Button Company, New York, N. Y., produced this unique Beach Hat which was awarded Second Prize in the Style Group. It is made of Lumarith, a cellulose acetate product of the Celluloid Corporation, and was created late this season by Max Silverman of the Paristyle Co.

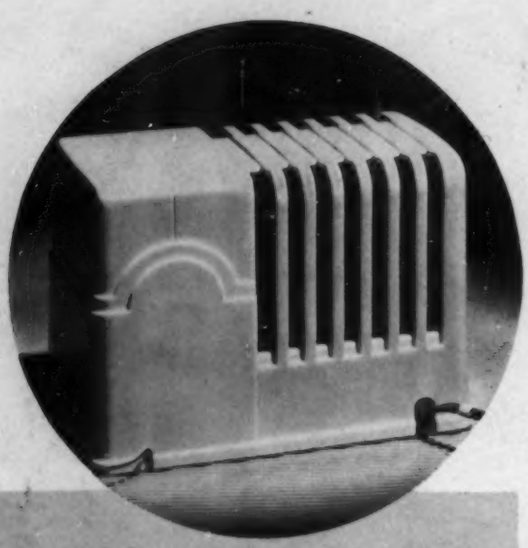
This smart beach accessory is light in weight, durable and sunfast. The material is washable and provides perfect sun protection for delicate skin. The hat can be made in any color and is so constructed that ventilation is allowed through the top section and around the band which fits the head. It is cut from regular sheet stock and laced on one side with ribbon. The promptness with which the judges pounced upon the novelty of this creation would predict a happy future for it during the coming Southern season and again next spring.

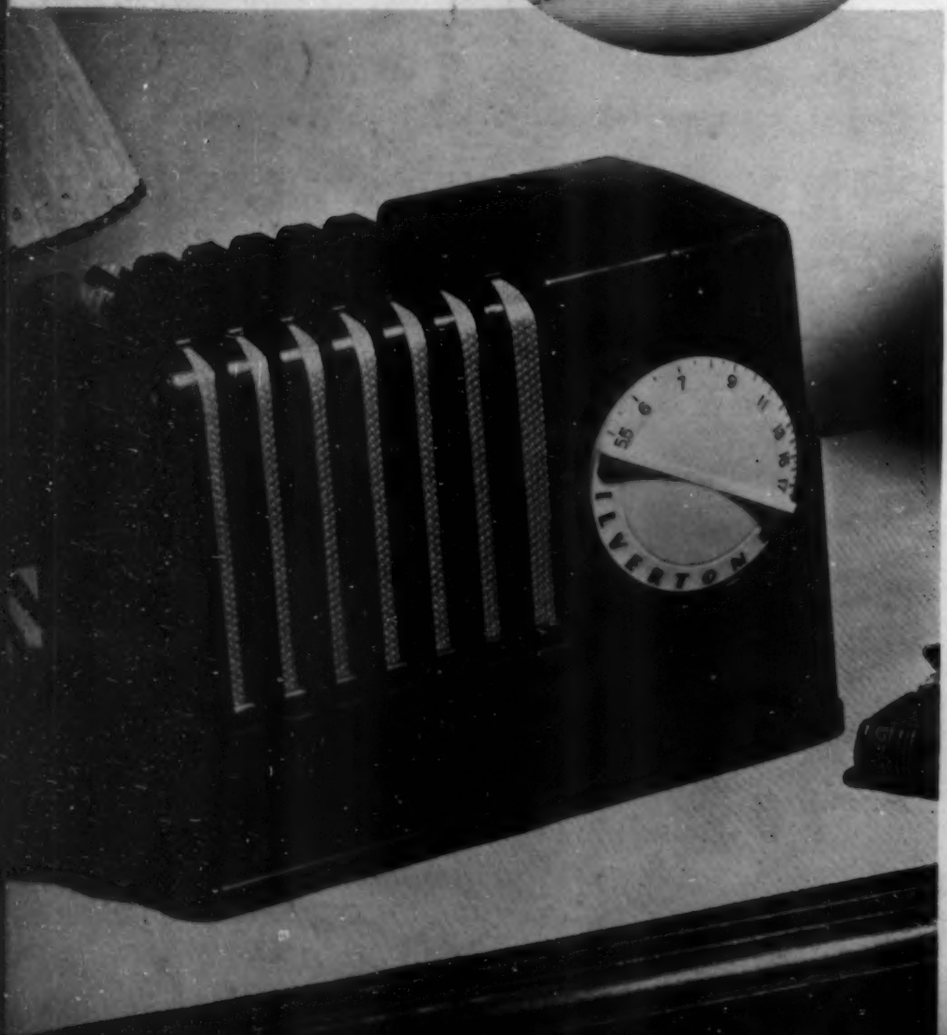


Hilf Bag Company, New York, N. Y. took Third Prize in the Style Group with its smart bag of soft gray suede having as its only ornamentation a slightly curved bar of clear Marblette, a cast resin plastic made by The Marblette Corporation, Long Island City, N. Y., and fabricated by Ace Plastic Novelty Co., Brooklyn, N. Y. Louis H. Steinman, of Hilf Bag Company, worked out the design.

"Plastic ornamentation for ladies' handbags offers an opportunity to exercise one's ingenuity in carrying out innumerable ideas in shapes and treatments," says Mr. Steinman. "Excessive weight is eliminated and the soft tones and colorings of the plastic material blend perfectly with colored leathers and fabrics. Color possibilities and contrasts are without limit."

FIRST AWARD DECORATIVE GROUP





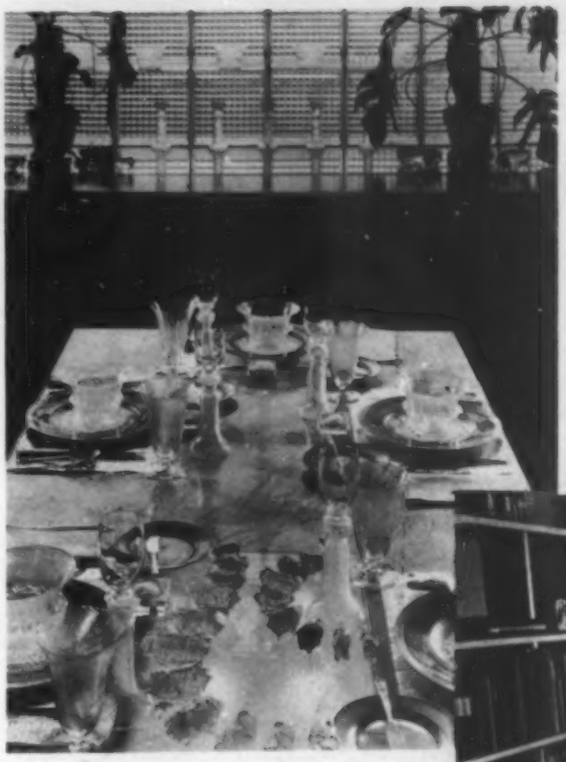
Sears, Roebuck & Company, Chicago, Ill., was awarded First Prize in the Decorative Group (which included all home accessories and furnishings) for its Silvertone Radio. The cabinet is molded of black Durez, a phenolic material made by General Plastics, Inc., North Tonawanda, N. Y., by Chicago Molded Products, Inc., Chicago, Ill. The ivory cabinets are molded of Plaskon, a urea material made by Plaskon Company, Inc., Toledo, Ohio. The dials are molded of Tenite, a cellulose acetate material made by Tennessee Eastman Corp., Kingsport, Tenn., by the Erie Resistor Corp., Erie, Penn. John G. Morgan, of Sears, Roebuck Co., was the designer.

The Silvertone Radio was chosen by the judges because it represents the most complete decorative use of plastics in a practical sense. Its functional and necessary features of construction have been worked into a decorative scheme that seems ideal. The design is accomplished so that the radio cannot be used as a shelf to be cluttered and the piece proceeds through functionalism to beauty.

SECOND AWARD DECORATIVE GROUP

The Modern Home of Morris B. Sanders, architect and designer, at 219 East 49th Street, New York, N. Y., was awarded Second Prize in the Decorative Group for the general architectural use of plastics throughout the house which indicates the effectiveness of the material for interior decoration. Formica, a laminated plastic manufactured by the Formica Insulation Co., Cincinnati, Ohio, has been effectively used for doors and for flat surfaces where other materials would be subject to damage in use. Resin used in the manufacture of Formica in black and dark colors was made by the Bakelite Corporation and the white and mottled Formica was made with Uformite resin manufactured by The Resinous Products & Chemical Company, Philadelphia, Penn. Mr. Sanders was, of course, responsible for the architectural design and interior decoration.

Formica was used notably for Mr. Sanders' desk in his ground floor studio, for the entrance doors to the building and his living apartments, dining-room refectory table, buffet and serving shelves, bulkheads, dressing tables, cabinets, fireplace mantles, occasional tables, card table, and wherever normal living would soon show signs of wear and damage to less sturdy contemporary materials.



THIRD AWARD, DECORATIVE GROUP

Manning, Bowman & Company, Meriden, Conn., took Third Award in the Decorative Group with its new Streamline Iron. The handle, which clearly shows a keen appreciation of style and imagination coupled with effective engineering is molded of Bakelite by the Watertown Manufacturing Co., Watertown, Conn. Jay Ackerman and E. A. Farr, of Manning, Bowman & Co., share honors in its design.

The Bakelite used is a heat resisting material which provides perfect insulation both for the electrical unit in the iron and for the hands of the operator who uses it. There is an indicating knob, also of Bakelite, which controls the heat for different fabrics and the complete ensemble is free from protrusions which would tend to catch either upon the cord or upon the garment being ironed. It is so designed that it requires no stand when not in use but may be simply up-ended and is sturdy when in that position. It is fully automatic in its control of current and persistently retains an even temperature at whichever point its regulator is placed when in operation.

MATERIALS

Phenolics
Ureas
Cellulose
Acetate
Pyroxylin
Cast Resin
Vinyl
Casein
Ethyl Cellulose
Acrylic Resin
Furfural
Cumarone
Polystyrene
Synthetic Rubber
Shellac
Fillers
Coloring of Plastics
Pages 17 to 108

Phenolic molding materials

BY C. W. BLOUNT *

AMONG the many questions the user of phenolic molding materials and molded parts should be able to answer are: What are they? Where do they come from? How are they fabricated? What are their properties and characteristics? For twenty-seven years phenolic molding materials have been employed industrially in the production of molded parts. Though industry may be familiar with their general appearance, their characteristics and established applications, this knowledge is, for the most part, too superficial.

The basis of the phenolic plastics industry is a synthetic resin, produced by reacting together phenol and its derivatives with formaldehyde and its derivatives in the presence of a catalyst. What is phenol? What is formaldehyde? These questions naturally arise. Phenol is one of the many chemical products obtained from coal. It is a by-product of the coke oven. It is also prepared synthetically by indirect oxidation of benzol, and by other methods. Formaldehyde is a gas, usually existing in a water solution. It is chemically obtained by partial oxidation of wood alcohol or methyl alcohol, which, until recent years, was obtained from the destructive distillation of wood. When the vapors of methyl alcohol are passed with air over finely divided metal, this metallic agent acts as a *catalyst*, that is, it aids reaction by its contact or presence, but without its becoming a participant in the chemical change which occurs.

In the process of manufacturing a typical phenolic resinoid, weighed quantities of phenol and formaldehyde solutions are put in a closed jacketed kettle and steam is turned into the jacket until the reaction proceeds actively. When the reaction is complete, which is a matter of a few hours, it will be found that the contents of the kettle have separated into two layers, an aqueous layer above and a layer of molten resinoid below. This product, free from water, is the basis of various forms of phenol resinoid materials employed by industry today. These forms comprise six general classifications:

1. Transparent materials.
2. Molding materials.
3. Laminated sheets, tubes and rods.
4. Liquid products—heat-hardenable varnish, lacquer, enamel and cement.
5. Synthetic resins for quick-drying finishes.
6. Special resinoids.

The resinoid obtained in the process just described is amber in color. This resinoid, in combination with various fillers, such as woodflour, alpha flock, cotton flock, asbestos, mica and graphite, produces molding materials. The all-important ingredient is the resinoid itself. It imparts to the molding material the properties of first softening upon the application of heat and pressure and quickly hardening. As a bonding and surfacing substance, it imparts to the molded products most of their distinctive properties. The purpose of the filler may be compared to the purpose of sand, gravel and cinders in combination with cement in the manufacture of concrete. Fillers are used for the added value they give to the molding materials—better moldability, greater toughness and strength, or, in the case of mineral fillers, an increased degree of water- and heat-resistance.

It is possible to produce from various raw materials an infinite variety of phenolic resinoids with all properties varying over an extremely wide range. The complexity of the properties and characteristics of phenolic molding materials may be further varied, depending upon the fillers used.

The manufacture of molding material consists of mixing together thoroughly by any suitable means a resinoid, filler, coloring matter and lubricants. One method of preparing molding materials is by means of a ball mill. The resulting product is very fluffy. Molding material is sometimes made dense by rolling it into sheets and grinding it. The appearance of molding materials in their raw state, depending upon the type, may be compared with that of granulated sugar, Grape-Nuts, cotton flock, uncooked oatmeal, and Corn Flakes. Fabrication of the resulting molding materials is accomplished in hardened steel molds so constructed that definite pressure is put on the material itself, the molds operating at a temperature of from 270 deg. F to 375 deg. F, depending upon the type of material being molded. Pressures applied on the piece range from 1,000 lbs. to 8,000 lbs. per square inch, also depending upon the material used and the part to be molded. Sufficient material is measured or weighed out to produce the required piece. It is placed

* Assistant Sales Manager, Bakelite Corporation

DUREZ

MAKALOT

RESINOX

in the mold, and the mold is closed with the simultaneous application of heat and pressure. Under heat and pressure the material first softens to the consistency of putty. It is forced into intimate contact with all parts of the mold. Continued application of heat "freezes" or polymerizes the material, converting it to its final state, after which it cannot be melted again. The material has been transformed into a homogeneous, solid mass as the result of pressure and the chemical change induced by heat. The mold is opened and the finished part or parts removed by various methods.

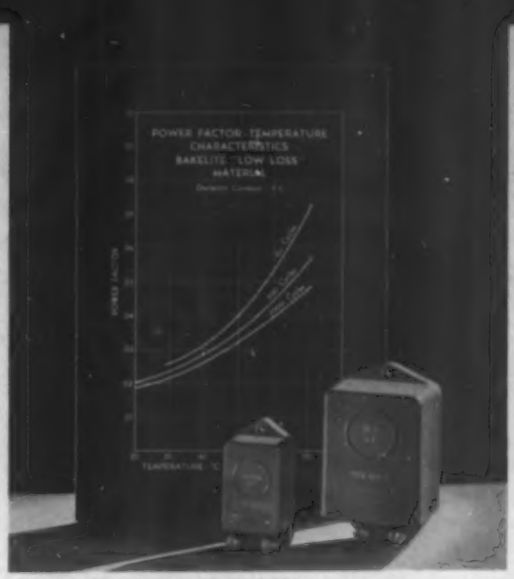
There is a popular conception that anything black or brown, such as a radio knob, switchplate, bottle closure, telephone receiver, camera case, and so on, is produced from the same type of phenolic molding material. The properties of any one part are assumed to be the properties of all kinds of molded parts. This is incorrect. Just as there are many types of steel for use in industry, depending upon the qualities desired, so there are many types of phenolic molding materials. The foregoing should not be construed to refer to the trade names of material manufacturers. It refers simply to the many variations of phenolic materials that are produced for specific applications. Each variation depends upon the use to which the finished molded part is to be put. Broadly speaking, phenolic molding materials can be grouped into three classifications, —Electrical, Mechanical, and Chemical.

GROUP I. ELECTRICAL

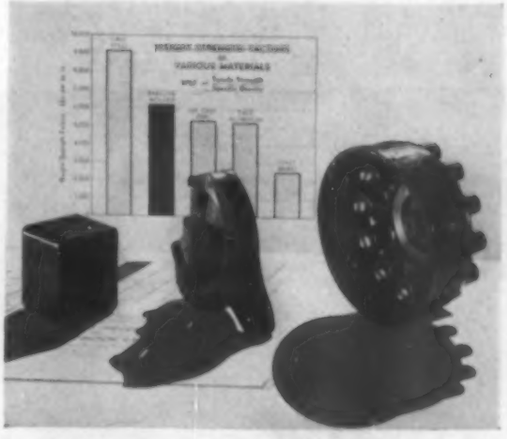
Phenolic molding materials in this first broad group are those intended for use as electrical insulation. It is impossible to divorce electrical properties from physical properties, since in the production of the part the user is interested in both. For example, glazed porcelain has certain advantages in electrical properties over the phenolic molding materials. However, the combination of electrical and mechanical properties of phenolic molded more than offset the advantages of glazed porcelain for many applications.

A. *General purpose electrical insulating materials.* These materials are used for a wide variety of purposes, such as wall receptacles, wall plates, twin lights, connector plugs, automotive ignition parts, radio parts, and the like. The following table of properties is representative of this class of materials:

Physical (Molded):
Specific Gravity 1.36, Weight per cu. in. 22.2 gms.
Tensile Strength 7500 lbs. per sq. in.
Modulus of Elasticity 9.8 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.13.
Impact Strength—Per Inch of Notch ft. lbs. 0.26.
Impact Strength—Lbs. Per Inch Square 1.63.
Molding Shrinkage .0065–.0085 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Max. Deflection at Center 0.060 ins.
Distortion Under Heat 284°F (140°C).
Water Absorption Loss 0.60%.
Water Absorption Gain 0.65%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 302°F (150°C).



PHOTOS, COURTESY BAKELITE CORP.



Top—Application of special "low loss" material for radio. Center—Special impact resisting material for oil well drilling. Bottom—Demonstration of weight-strength factors of various materials. With a specific gravity of only 1.36, and a tensile strength of 8500 lbs. per sq. in., phenolic molded has a weight-strength factor of 6250

Electrical (Molded):
Dielectric Strength at 60 Cycles 325 Volts per Mil.
Power Factor at 60 Cycles 0.33.

(Continued on page 99)

Urea formaldehyde molding compounds

BY WHITING N. SHEPARD*

UREA formaldehyde molding compounds though but recently come to the field of plastics have filled certain definite needs, a fact which accounts for their rapid growth and acceptance by industry. They were developed principally to provide lighter colors than were available in phenol formaldehyde compounds which when introduced about 1908 offered to the molding industry an entirely new type of plastic material, thermosetting or non-reworkable. From the 600,000 pounds of urea materials produced in 1931, production increased to about 6,400,000 pounds in 1935, and this year's production promises to be larger than last.

Commercial urea formaldehyde molding compositions were offered for sale in this country about 1929. These could be molded as rapidly as phenolics, in ordinary steel molds, and were only slightly more expensive to produce. The resin itself was water-clear and by using highly refined colorless alpha cellulose pulp as a filler, pure white and delicately pastel tints were obtainable in the finally molded products. The higher reflectivity and polish of the urea moldings as compared with the phenolics, was due to the depth of color of the new composition. The urea molding compositions did not and were not intended to supplant the phenolics, but rather to complement them. Nevertheless, the urea molding compositions have, in the past five years, been the most rapidly growing branch of the industry. Its ramifications are legion.

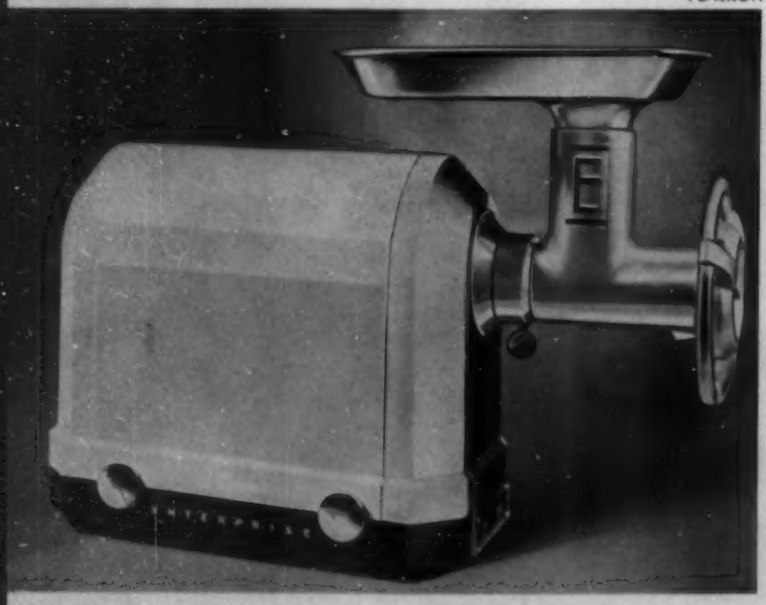
* Plaskon Company, Inc.

The unique characteristics of urea plastics are not widely known, and it is generally assumed that beautiful coloring is their only excuse for existence. Such, however, is not the case. It is true that beautiful colors have been produced in ureas because the base, or "natural" compound is colorless but, further, completely *lightfast* shades are produced.

Molded urea plastics have certain other unique characteristics worthy of mention. Practically any color can be made and guaranteed by the manufacturers as absolutely "non-bleeding" in alcohol, acetone, or any common solvent. Urea plastics are tasteless and odorless as witnessed by their continued successful use in the manufacture of molded tableware in which hot foods and liquids are often used. The surface of the molding is pleasant and smooth to the touch, and it has the luster and polish, in addition to colors, which attract the eye. Being infusible and high in nitrogen content they, like the phenolics, will not support combustion but will char and lose their color at high temperature.

Because of their hard surface and imperviousness to grease, urea moldings offer a unique resistance to surface deterioration. Test pieces have been exposed to the elements for periods as long as 2 years without noticeable loss of finish, and gasoline pump illumination frames, exposed to the rigors of the weather all over the country have stood up far beyond their expected life. For similar reasons moldings may be

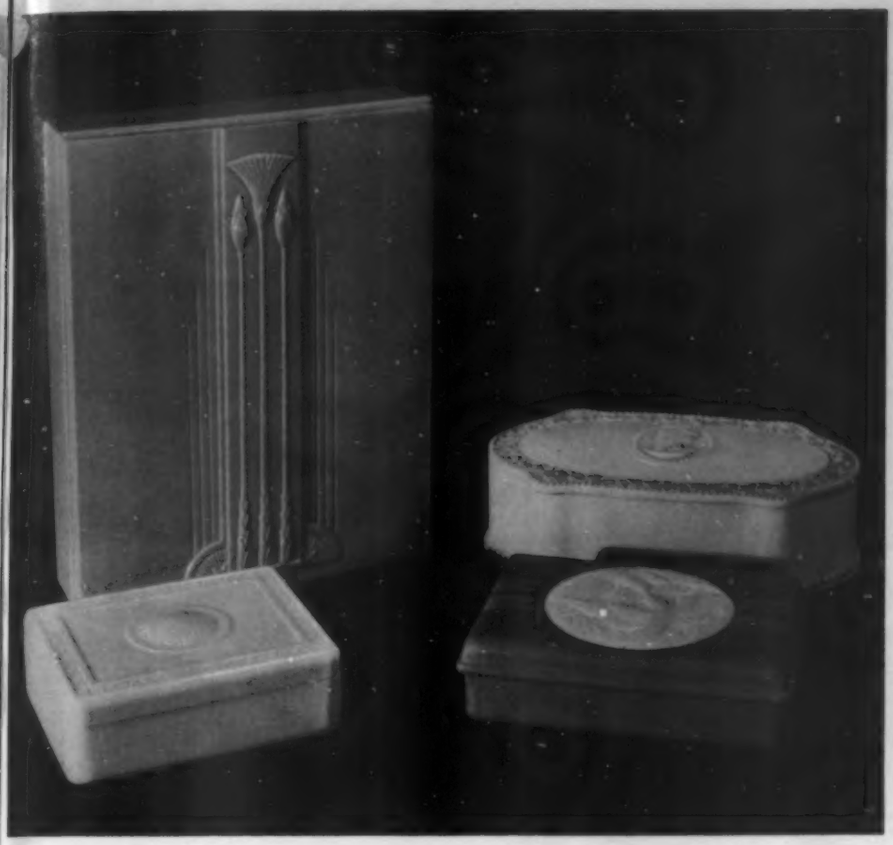
PLASKON



Enterprise meat chopper recently appeared with an ivory white housing of molded urea

BEETLE

Premiums by the million are made of urea and distributed by advertisers each year



Pierre Chéron designed these boxes of Beetle which were molded by Gorham

Handles of Plaskon are commonly seen on modern gas and electric stoves

frequently handled and washed day in and day out still the polish and luster remain intact. In fact they tend to improve in polish when handled.

The ureas also offer unique resistance to common organic solvents, beyond the fact that colors may be made "non-bleeding." Urea moldings can be submersed in alcohol, acetone, etc., for indefinite periods of time without harmful effect. They are likewise completely resistant to greases and oils, molded containers having been extensively used in the packaging of creams and salves having oil or grease bases. In this connection it is well to point out that aqueous creams are not generally packaged satisfactorily in these containers, because of the tendency of the material to swell slightly on continuous contact with moisture, but some carefully designed containers have successfully overcome this difficulty.

Further, urea moldings are quite resistant to weak alkalies such as soap and borax but only fairly so to weak acids. Strong acids and alkalies exert a markedly deleterious effect, and should not be brought in contact with them. As regards electrical properties, ureas compare very favorably with phenolics, and for use in connection with radio, are considered superior because of their lower power factor at high frequencies. Molded ureas have been found to offer superior resistance to arcing, and are replacing established materials in many instances in heavy duty electrical equipment where "tracking" causes trouble.

Recent tests conducted on urea moldings at the Electrical Testing Laboratories indicate that ureas maintain excellent insulating qualities after immersion in water, or after contact with damp air. In this respect, urea's superiority over other type hot molded compounds, makes it an excellent insulating material for the more damp climates.

Moldings are shatter proof and resilient but are in no sense of the word "unbreakable." Possessing as they do a certain degree of flexibility, they may often be dropped onto hard surfaces without fracturing, but continued abuse will have its effect. The modulus of rupture is between 10,000 and 14,000 pounds per square inch while the tensile strength is from 8,000 to 13,000 pounds per square inch. Here, as in the table of physical properties, the range of values is largely due to the degree of cure, the highest properties not being required for most applications.

It is perhaps well to mention here that special types of ureas, comparable to the special grades of phenolics (such as canvas-filled, asbestos-filled, etc.), are not manufactured. The urea materials now produced are approximately twice as expensive as standard black and brown phenolics but compare favorably in price with better phenolic colors. Both materials may be run interchangeably in the same molds, and frequently are. Hence a manufacturer may use black phenolic handles on a low priced stove, and pastel green urea handles on more expensive (*Continued on page 81*)

Cellulose acetate plastics

BY SPENCER E. PALMER*

TENNESSEE EASTMAN

1

2

1. Door knob and switch plate in which most attractive combinations of color become possible through molding. 2. Cellulose acetate is available in sheets, rods and tubes of various sizes as well as in the form of molding compounds for injection or pressure molding

CELLULOSE acetate, the basic material from which the type of plastics known by that name is made, is one of a large family of cellulose esters. Cellulose acetate is fundamentally cellulose, usually in the form of purified cotton linters, esterified with the use of glacial acetic acid and acetic anhydride. Cellulose acetate looks more like snow flakes than anything else with which every one is familiar. Of the many cellulose esters only two are widely known commercially, cellulose acetate and cellulose nitrate. Cellulose nitrate plastic differs from cellulose acetate plastic in that it burns quickly and violently. Cellulose acetate plastic materials are non-hazardous, burning merely like hard rubber, wood, heavy cardboard and similar materials.

There are many types of cellulose acetate, classified primarily by their viscosity as measured in acetone solution, and the degree of esterification measured by the acetyl content. Basically cellulose acetate is more expensive than cellulose nitrate, since it is made with a relatively expensive organic acid, while the nitrate is made with a considerably cheaper inorganic acid, and is controlled in the process of esterification with less expense. Cellulose acetate finds its largest applications in yarn for dress goods and fabrics, plastics, safety motion picture films, and lacquers.

Acetate plastics may in turn be divided into sheets, rods, and tubes for fabricating, and blanks and granulation for molding. The former, being a relatively finished product as opposed to blanks and granulation for subsequent molding, is somewhat more costly. Sheet acetate plastic finds its greatest use in laminated safety glass. Its markedly greater stability to light and heat makes its use for this purpose and others preferable to cellulose nitrate material, which has a tendency to yellow with age.

Cellulose acetate alone cannot be commercially molded. The addition of a plasticizer gives the material the necessary quality for flow in molding and imparts resiliency to what would otherwise be an extremely brittle material. A plasticizer can be described

* Sales Manager Cellulose Products Division, Tennessee Eastman Corp.

as a softening agent which forms with cellulose acetate a so-called solid solution.

Although cellulose acetate is basically more costly to manufacture than cellulose nitrate, new rapid processes of making the molding composition in blank and granular form for subsequent molding permit the sale of that class of cellulose acetate plastic at a price somewhat less than corresponding color classifications of cellulose nitrate plastic sheet.

The strength in resistance to impact of an article molded from cellulose acetate plastic is unexcelled by that of any other type of molding composition. This is due to the homogeneous nature of the product and its resiliency, measured in elongation, which cushions blows. Many applications represent safety features secured by the high resistance to impact of acetate molded articles; for instance, protective goggles, miners' lamp housings, steering wheels, and oil cups and gauges which take the place of relatively easily broken glass. Color, usually combined with considerations of strength and resiliency, accounts for a vast number of applications such as knife handles, radio grilles, adding machine and typewriter keys, combs, hair ornaments, buttons and buckles, door knobs, and golf tees.

Cellulose acetate plastic is fundamentally clear transparent. Translucent and transparent colors, as well as mixed colors, are secured by the use of suitable pigments and dyes. It is possible to secure practically any color effect desired. Acetate molding composition is used on the interior appointments of twenty-six makes of motor cars this year; variously for steering wheels, knobs (gear shift, cigar lighter, radio control, window regulator, cowl ventilator, windshield wiper), escutcheons, door-lock bushings, compartment handles, horn buttons and retainer rings, dash controls, and instrument panel indicators.[1]

The strength factor of acetate in such applications is well illustrated by the fact that a dash control knob molded from acetate can be driven onto a shank with ratchet teeth, so that it will remain there positively and securely, without the risk of breaking the piece in the course of this operation. No other type of plastic will stand such treatment. Obviously, if it were not possible to do this it would be necessary to mold the knob on the metal shank, making for additional shipping weight, bigger molds and longer molding cycles.

Typical other qualities which account for acetate applications are high dielectric strength, smooth surface, and low heat conductivity. Cellulose acetate molding material is a thermoplastic similar to shellac, for instance, and can be remolded. The phenol and urea materials are thermosetting. Acetate is set by chilling, while the thermosetting compositions are formed under continuous heat, hardening through a chemical reaction. A material cannot have great heat resistance, like a thermosetting material, and still be remoldable. The fact that acetate is remoldable is an advantage in some instances, while in others the necessary corollary that it does not have high heat resistance is a disadvantage. Acetate materials are attacked by certain chemicals which for some purposes eliminate their use.

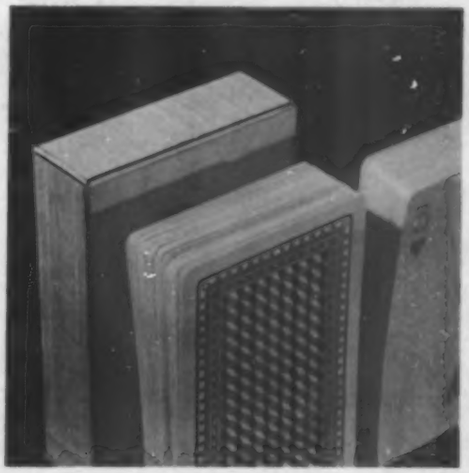
The relatively wide use of acetate plastic is a development of the last five years. The speed of molding

[1] Refers to Tenite

(*Continued on page 98*)

CELLULOID CORP. 3

DU PONT



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3. Lamp shade of cellulose acetate especially decorated to match the wooden base of the lamp. 4. Playing cards of acetate material may be washed with soap and water and will wear almost indefinitely

The smooth, easily cleaned surface of pyroxylin makes it ideal for bathroom use. Its colors are without limit and unusual mottled effects are frequently used. (Photos in this article, courtesy Celluloid Corp.)

Pyroxylin (cellulose nitrate) plastics

PYROXYLIN plastics owe their origin to cotton, which is considered one of the purest forms of cellulose. Cotton linters treated with a combination of nitric and sulphuric acids render them soluble and workable. The resultant product is called cellulose nitrate or nitrocellulose and dates its discovery to Dr. Schonbein of Switzerland in 1846. The tendency of nitrate and sulphuric acids to form different kinds of cellulose nitrates explains the varied character of their reactions. Cellulose nitrate with a high percentage of nitrogen, about 13%, forms gun cotton, highly explosive and so stubborn in the presence of solvents that it becomes insoluble and unfit for the manufacture of cellulose nitrate plastics, whereas cellulose nitrate with a low percentage of nitrogen—about 10.5 to 11.5%—is of an entirely different character and is noted for its plastic disposition.

This cellulose nitrate of low nitrogen content is known as pyroxylin. The term cellulose nitrate or nitro cellulose for plastics made of it is a misnomer, therefore the manufacturers of these products have preferred to identify their plastic materials as pyroxylins. The use of this soluble nitrated cotton for the manufacture of plastics was discovered by Hyatt through the use of camphor both as a solvent and plasticizer for the pyroxylin. By thoroughly mixing the two together and then pressing the mixture while under heat the camphor and pyroxylin combined into a solid mass. The use of a small quantity of a liquid solvent, such as alcohol readily removable by seasoning, was found desirable to assist the fusion of the camphor and give quick solvent action.

Process

Pyroxylin plastics are essentially solid or colloidal solutions of cellulose nitrate in camphor. Sheets, rods, tubes and rolls made of this material are seasoned or cured at elevated temperatures to remove the volatile alcohol which has performed its function of assisting the colloidalization of the pyroxylin. The curing period may be from a few hours to six months or more depending upon the thickness of the stock. After seasoning the materials are surface finished in any one of a number of effects and are ready to be fabricated into a multitude of articles.

Color

Because of the process employed in the manufacture of pyroxylin plastics innumerable colored and variegated effects are possible. By the medium of dies and pigments which may be incorporated in a plastic mass in an endless variety of ways extremely attractive and beautiful effects are obtained. In other words, the mechanical manipulation of the material during its process of manufacture enables colorists to obtain any desired effects difficult to obtain in other plastics.

Forms

Pyroxylin plastics are available to the fabricators in the form of sheets, rods, tubes of various dimensions and rolls (continuous lengths.)

a. Sheets are usually standardized at 20 in. x 50 in. in area, and range in thicknesses from 0.003 in. to over 1.00 in. The surface of the sheets may be highly polished, matt finished, or embossed with intricate designs or configurations.

b. Rods may be obtained in diameters from about 0.050 in. to over 2.00 in.

c. Tubes may be supplied in practically any required size to a minimum wall thickness of about 0.015 in.

d. Rolls may be supplied 21 in. and 42 in. wide from 750 ft. to 1000 ft. long in thicknesses of .003 in. to .10 in. inclusive.

Application

Pyroxylin plastic is a true thermoplastic, i.e., it softens upon the application of heat and sets upon cooling and is, therefore, readily fashioned by molding, bending and machining into a wide variety of articles. This property coupled with its decorative quality makes it ideally suitable for such articles as dressing table sets, umbrella handles, novelties, toiletware, fountain pens and mechanical pencils, veneered toilet seats and towel racks and numerous other articles. Its toughness, strength and wear resistance finds application in safety glass, wooden shoe heel covers, automobile curtains, airplane windows, cutlery handles, golf shaft covers, shoe lace tips, tooth brush handles, dental plates, harness rings, etc. Its uniformity and resistance to dimensional changes is utilized in mathematical and precision instruments, optical parts, and in tracing material for map making. In the musical field it is used for piano keys, banjo buttons, organ stops, mandolin picks, etc. Its ability to take printing is taken advantage of in the advertising field for blotter covers, cards, campaign buttons and novelties. Numerous other applications may be mentioned such as radio dials, register wheels and buttons for calculating machines, screw driver handles, pocketbooks and many others. *(Continued on page 94)*

Above—Eyelets and buttons may be molded or shaped from rod and tube stock. Below—Pyroxylin makes a practical heel covering. Its luster is lasting and it is not easily scuffed

Toiletware was one of the original uses of pyroxylin and much of the current production still employs this material

Cast resins—and how they are used

BY D. K. BANCROFT*

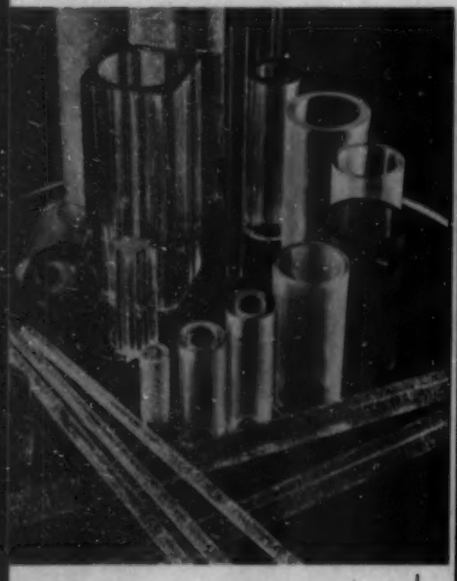
Since cast resins were reviewed in one of the earliest issues of MODERN PLASTICS (November 1934), these important plastics have forged steadily ahead. Their use is extending into new fields and many established users have employed them in increasing quantities. Production in 1935 reached a total of about 5,000,000 pounds in this country and is likely to gain a still larger total this year.

Cast resins are differentiated from molding types partly because they are cast in liquid form initially. They are converted into consumer products, not by molding but by machining. Thus, the fabricator does not require molding equipment and the cost of this equipment and of the molds themselves is avoided. This makes it feasible to use cast phenolics for numerous applications in which, if expensive molds were required, it would not be practical to employ a plastic at all. Thanks to rapid methods of machining, products required in large quantities are also produced from cast plastics at relatively low unit cost. Hence the cast forms enter into both small production and large production fields.

Although cast phenolic plastics are somewhat more expensive on a pound basis than molding phenolics and the powdered urea molding compounds, the elimination of mold costs enables them to compete in many instances. In general, however, the character of applications is quite different. This is partly because cast phenolics possess unique color possibilities and a degree of translucency that fits them for decorative applications. Cast resins do not employ a filler and so can be made transparent—even water white and crystal clear—if desired. Clouded and other translucent effects are secured by adding dyes or pigments. If these are properly combined, the coloring is uniform, but variations in the process are sometimes introduced to produce attractive mottled or cloud-like effects. Opaques are made with heavier pigmentation. Brilliant as well as delicate shades or even white are readily produced.

Casting is done much the same as with metals but at far lower temperatures. In addition, the cast resin does not harden rapidly by cooling, as do metals. Hardening is effected by curing in ovens for a period of three to six days under moderate temperatures.

* American Catalin Corporation.



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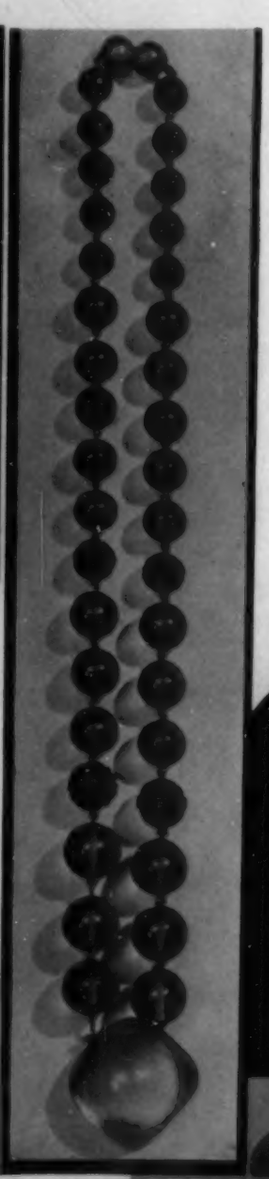

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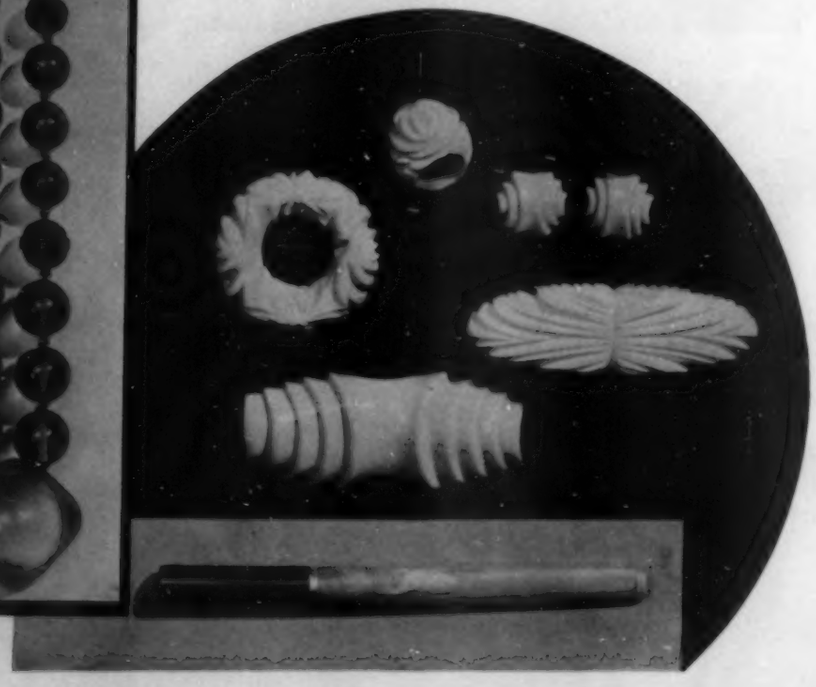


1. Rods and tubes of transparent cast resin, in which gold or silver flakes have been floated in the liquid resin to give a mottled effect. Others are clear transparent. 2. Shows beads, clips and cigarette holder which have been fabricated from cast resin

CATALIN

Most casting is done in molds of lead, made by dipping steel forms into the molten metal and stripping the thin shell of lead which "freezes" around the form. These lead molds are easily and quickly formed and are then set into frames, filled with liquid resin and the frame removed to a curing oven. Subsequent to curing, the castings are removed from the molds which are remelted and formed into new molds.

Designers of products to be made from cast phenolics should have some knowledge of this casting process as it naturally controls the shape and size of the castings. Castings are slightly tapered to facilitate their removal from the mold. They are square or flat on top because the liquid resin naturally "levels off" when cast. Lead molds cannot be undercut as this would interfere with the removal of the casting and in general are limited to about 20 to 24 in. in length. Tubes, called "cylinders," are usually cast about 10 in. long. Rods may be circular, square, or of odd contour—fluted, for example—and the same is true of the outside of tubes. The latter have holes cored from end to end and the holes can be single or multiple and of almost any shape. Thus, for example, the casting may have a section like a spoked wheel, with perhaps eight or more cores forming the openings between spokes. A piece sliced from such a casting will, of course, have the shape of a wheel. Tubes with one or two large cores can be cast in longer lengths than those with several small cores. A large assortment of dress buckles and slides is made from castings with two holes forming the openings in the buckle. In general, it is not economical to cast walls and other sections thinner than $\frac{1}{8}$ inch.

It is a simple matter to shape bars, tubes or other forms of cast resins by machining and many items are made this way, especially when the proportion of material machined away is small. When an article such as a tapered handle for cutlery, kitchenware and the like, a pipe bit, or a Zeppelin-shaped casting like the ornament on Hudson and Terraplane cars is required, it is often less expensive to have such a part cast to size. There are, however, many standard forms for items such as those mentioned, and castings of this kind are offered in a large assortment without extra charge for the stock form. Such castings need little or no machining except for tumbling and polishing to make them ready for use. A thin flash must be cut or ground from the large end and in some cases this must be shaped by simple machining operations. Such work is rapidly done, costs little, and involves only a minor waste of material.

As with metals, some types of fabricated parts produced from cast resins are made to best advantage from sheet or slab stock. The resin may be cast in a shallow pan or between sheets of glass. Sometimes they are made into thin sheets by casting a thick slab and, when this is partly cured, slicing the sheets in a suitable machine and then returning them to the oven for completion of the cure. Sheet stock is readily sawed and can even be stamped in a suitable press, using a sharp-edged tool, if the sheet is properly warmed before stamping.

Despite the utility of specially shaped castings, the largest part of cast phenolic production is in rods and tubes of either circular or other standard or odd section. Millions of buttons and buckles are made by machining from rods and tubes of this kind, as are handles of various kinds, bracelets, brooches, earrings and other costume jewelry, parts for furniture and hardware. For making thin blanks, a relatively new form of slicing machine which cuts rods without waste is now used and results in considerable saving of the plastic material.

CATALIN

3. Buttons and buckles in hundreds of different designs are cut from rod and specially shaped stock, where the brilliant colorings of cast resin are particularly appropriate to style application

Parts produced from cast phenolics, whether machined to size or cast, do not usually come from these operations ready for use. They have a frosted surface which hides the natural beauty of the material and tool marks often show. The surfaces require polishing, especially where decorative carving is applied. Polishing usually starts with tumbling with shoe pegs and pumice. (See article "Buffing Wheel and Tumbling Barrel" page 280.) This removes sharp corners and tool marks. After removing all pumice, further tumbling with proper preparations yields the desired luster. Occasionally, however, wheel polishing is done with muslin wheels. The luster produced by either method is enduring and adds greatly to the beauty of the piece, bringing out the natural brilliance of the material.

From the foregoing it will be apparent that cast phenolic plastics are quite different from the molding types. They have found wide use partly because they are readily worked in much the same way as metal or wood. In fact, the same machines used for wood and metal working are often employed for working cast resins. In numerous instances, a company making metal products purchases cast plastic in bar, tube, sheet or special castings, performs such cutting and polishing operations as may be required in its own plant, and applies the plastic parts thus fabricated to its own product. Other makers prefer to employ fabricators who specialize (*Continued on page 86*)

Vinyl resins and their applications

BY J. R. PRICE*

THE history of vinyl resins goes back to 1838. At that time Regnault[1] observed the formation of a white powder when sealed tubes of vinyl chloride stood in the sunlight. In 1872, E. Bauman[2] polymerized the vinyl halides to white solid masses, "unaffected by solvents or acids." From these early discoveries has come the commercial polymerization of various vinyl compounds under conditions which give synthetic resins possessing properties which make them suitable for widely diversified industrial usage.

Classification

The vinyl resins are formed by polymerization and are truly thermoplastic resins. No chemical reaction takes place when these resins are molded and they retain their thermoplastic nature in the molded article. True thermoplastic material, such as vinyl resins, can therefore be re-molded if necessary, and because of this property economies often result which cannot be secured with thermosetting resins.

Types commercially available[3]

This group of resins includes those made from the polymerization of vinyl acetate as well as vinyl chloride and chloride-acetate resins resulting from the copolymerization of both of these products. While the properties of these different resins vary somewhat, they possess the unique characteristics of being odorless, tasteless, non-flammable and non-toxic; and with the exception of the polyvinyl acetate group, they are inert to the action of acids, alkalies, alcohol, water, oil and grease. These resins are produced originally as a white fluffy powder from which they can be formed into transparent, translucent or opaque articles. Their original clarity makes it possible to produce the most exacting and delicate shades of colors.

All plastics have their limitations, and the unusual properties of one material which make it highly suitable for one specific use may be the same properties that prevent its use for another application. The wide range of vinyl resins commercially available makes them unusually interesting to many industries where heretofore plastics have played a relatively unimportant part. In evaluating the merit of vinyl resins for an individual application it is necessary, of course, to know the physical and chemical requirements of the application itself and to select from the commercially available resins a type which will meet these requirements. This has been done in many instances and resins highly suitable for individual applications are now being supplied on a commercial scale.

Applications

The field of surface coating is a large, important one, covering a multitude of different applications, and vinyl resins are playing an important part as a surface-coating material. When applied to metal these resins make a strong, tough film which permits subsequent drawing or stamping of the metal without destroying the film. These coatings are resistant to alkalies, alcohol, grease, water, and most corrosive agents. They are, of course, tasteless and odorless and have found wide use in lining metal containers for beverages and foods, as well as metal caps used in the packaging of such products. Beverages which require the most exacting protection from metal containers, to preserve their delicate flavor and original appearance, are successfully packaged commercially in metal containers through the use of linings made from such resins as protective agents.

Surface coatings made of these materials are also widely used for artificial tile, paneling, swimming pools, for coating metal foil and many articles which are in every day use in millions of homes. The resistance of surface coatings made from vinyl resins to alkalies, makes them an unusual material for coating cement surfaces. The alkalinity of cement which usually affects other types of paints or lacquers, has no effect upon coatings made from them and their use on concrete surfaces results in a highly satisfactory permanent finish.

In surface coating formulations the ketones are used as solvents. Among those commercially available are acetone, methyl ethyl ketone, methyl isobutyl

* Carbide and Carbon Chemicals Corporation

[1] Ann. chim. phys. (2) 69, 157 (1838)
[2] Ann. 163, 308-22 (1872)
[3] Refers to Vinylite (Trade-mark registered by Carbide and Carbon Chemical Corp.)

This three-ton glass panel over the entrance to the Palazzo d'Italio, is cushioned with Vinylite as are the panels over all the other entrances at Rockefeller Center, New York. Its ability to absorb the expansion of glass in each individual joint creates a safety factor unattainable with other material

ketone and methyl n-amyl ketone. These solvents possess a high tolerance for coal tar hydrocarbon diluents which are used in the formulation of the coatings.

In fabricated form, vinyl resins are available commercially in sheets, rods and tubes, and as a coating on paper or cloth. Certain of the resins may be readily molded by conventional methods. Although up until the present time the commercial development of fabricated forms of vinyl resins has been limited to a relatively few types of articles where specifications have been developed to meet their individual requirements, unquestionably these resins will find wide application in the general fields of sheets, rods, tubes and coated fabrics.

It may be interesting to examine the properties which have made vinyl resins outstanding in a few of the fields where they are commercially used in large quantities today.[4] A large proportion of the records used for electrically transcribed programs over the radio are made from vinyl resins. The unusual accuracy with which sound tracks can be molded in this material results in remarkable fidelity of sound reproduction. The characteristics of the resin permit the placing of sound tracks much closer together than on records made of many other materials, and consequently longer programs may be recorded on a given surface area. Records made from these resins do not warp or shrink; they have a remarkably low noise level, long life, and are practically unbreakable. All of these properties taken together make a superior product, the merit of which has been recognized by record producers with the result that this is a rapidly expanding use for these resins.

Vinyl resins have found wide usage in dentures. This exacting application requires strong, tough material that is tasteless, odorless, resistant to mouth acids and non-irritating to mouth tissues. All of these properties are found in these resins which also permit the reproduction of the delicate pink shades required.

Paper coated with a thin film of vinyl resin has firmly established itself as a superior liner material for the packaging of foods, beverages, drugs and cosmetics. Requirements for a satisfactory liner are very exacting. The material must be resistant to the action of most reagents so that it will be suitable for the packaging of an almost infinite number of different types of products. Where foods and beverages are involved it must be tasteless, odorless and non-toxic. Practically all liner applications require a material with extremely low moisture transmission. These qualities, and the clear, white, glossy appearance of vinyl resin coated paper have resulted in the widespread use of this product, which to a large degree has simplified the cap and liner manufacturers' problem of finding a nearly universal material that will permit the elimination of many of the special papers which formerly had to be stocked for limited applications.

Vinyl resins are also extensively used for the impregnation of fabrics. Felt so treated is used for forming box toes for shoes. Starchless collars are another typical example of the commercial application of these resins for fabric impregnation. The collars are laundered in the usual manner and after ironing and cooling remain stiff without the use of starch.

[4] See properties chart opposite page 108

A family group of Vinylite moldings showing a wide diversity of application. Phonograph records and those used for electrical transcription in radio make extensive use of this material

Vinyl resins are readily molded and their machinability factors are excellent. They can be worked on the lathe, milled, shaped, drilled and adapted to threading and tapering, centerless grinding, spinning, sawing, stamp cutting and sheering. They take an extremely high polish. The low moisture absorption and faithfulness of reproduction make molded and machined articles extremely satisfactory, and with the almost unlimited possibilities it is safe to anticipate a wide application of these resins in the molded article field.

The commercal development of this group of vinyl resins to date indicates the diversified possibilities of these materials and their extreme versatility. The raw materials from which the resins are derived are considered inexhaustible and with the rapidly expanding commercial development, they should find many new fields which have heretofore been closed to them because of the higher prices they have demanded due to small scale production. On the basis of performance and probable cost it is reasonable to expect that this group of resins will play an important part in the rapidly expanding field of plastics.

Buckles and buttons consume the major portion of casein plastics, but they are equally adaptable to many novelty items as well. (Photo, courtesy American Plastics Corporation)

Casein plastics

BY C. S. LAWRENCE*

CASEIN plastic is one of the older plastics having been produced commercially in Europe about 1904. It is non-inflammable in that it will not support combustion. It is made from casein, a product of cows' milk, which after being pressed into sheet and rod form is cured or seasoned in a formaldehyde solution. The sheets and rods are then dried and straightened. The standard size sheet is approximately 16 by 20 in. and the rods are about 42 in. long. These measurements are generally adhered to by both the American and European manufacturers.

The curing or seasoning and the subsequent drying take considerable time, and as a result sheets thicker than 6 mm. (approximately 1/4 in.) which take about six weeks to make, and rods larger than 5/8 in. which take about six months to make, are not made by American manufacturers except to order. The thickest sheets made are 12 mm. (approximately 1/2 in.), and the largest diameter rods made are 1 inch.

Round tubing is also made, and the general rule is that the bore of the tube shall not exceed one-half the diameter of the tube. If the walls are thinner the tube is apt to become oval while being extruded. The surface of the finished tube can be ground to the required size, but the bore of the tube is rough and usually is a little out of round and off center. Rods and tubes have a rough surface when made and must be ground smooth to required diameters. For this reason only round rods and tubes are made commercially.

All casein composition is somewhat hygroscopic, and is therefore affected to some degree by atmospheric changes. Experience has proven that sheet stock larger than 4 in. square has a tendency to warp. Its most successful uses are for small articles where color, appearance and durability are the first consideration.

It can readily be understood that a material which when molded to shapes of varying dimensions and thicknesses, curing more rapidly in the thinner parts of the article than in the thicker, would go out of shape. This difficulty alone has deterred the use of casein plastic as a molding material, and generally speaking, casein plastic is considered neither to be moldable nor is it available as molding powder.

Casein plastic is made in a large range of opaque and translucent plain colors. Many mottled effects are also made. Originally, the mottled effects were principally imitations of horn, but now many different types are made such as metallics, mosaics, jade, and other semi-precious stone effects, and most recently pearl effects.

It can be sawed, ground, cut, turned, and carved, without difficulty, and manufacturers equipped to work metal, wood, pearl and similar materials, find much of their equipment can be used in the working of casein plastic. The rods can be turned on either hand or automatic screw machines. They may also be cut into small pieces which are then ground to the

(*Continued on page 108*)

*American Plastics Corporation

Ethyl cellulose plastics

BY D. R. WIGGAM*

ETHYL cellulose is a cellulose ether that has been known for many years in the research laboratory. Only recently, however, has it been available in commercial quantities in this country. Ethyl cellulose is prepared by the reaction of ethyl chloride on alkali cellulose and is supplied as a white granular powder. Because of the stability of the ether linkage between cellulose and ethyl groups, the material is not subject to hydrolysis common to esters. It possesses the toughness usual to cellulose derivatives and because of its solubility in and miscibility with a wide variety of plasticizers and resins, it is quite easy to formulate. The toughness at low temperatures of molded compositions made with ethyl cellulose indicates that there is an unusually close union between the cellulose derivative and the plasticizer. This likewise is partially responsible for the ease of molding by the usual methods, whether by compression or injection molding.

Ethyl cellulose, in combination with a plasticizer, produces plastics which are colorless and transparent. The material is unaffected by alkalies of any concentration or by dilute acids. To produce a plastic of equal chemical resistance, plasticizers must be selected which are likewise resistant. It is not discolored by ultra violet light within the sun's spectrum, and is not discolored by heat within the range necessary for molding. Plastics produced with ethyl cellulose are lighter in weight than most molding compounds, because of the low density of the material; density is 1.14. Ethyl cellulose is no more inflammable than cellulose, and plastics can be made entirely non-inflammable by the use of some of the chlorinated and phosphate plasticizers.

Because of its ready solubility, ethyl cellulose is miscible with a wide variety of plasticizers and resins. Some of the useful, common plasticizers are dibutyl phthalate, diethyl phthalate, dimethyl phthalate, tricresyl phosphate, esters of glycolic acid (Santicizer B-16 and Santicizer M-17), chlorinated diphenyl (Aroclor 1260), esters of abietic acid (Hercolyn), and the vegetable drying oils such as cottonseed, perilla, soy bean, and linseed. It is compatible with many of the modified synthetic resins of the phenolic, glyptal, and ring hydrocarbon types; its solubility in rosin is complete. It is also compatible with many of the waxes, such as beeswax, montan, (*Continued on page 107*)

The effect of ethyl cellulose on the waxes is illustrated in the following examples with purified montan wax. Similar results are obtained with other waxes and resins.

Montan-pure	Ethyl Cellulose	Fused at	Solubility	Softening Point	Melting Point	Casts
100	0	..	..	68.5	69.5	Fair
90	10	150°C 5 Min.	Good	73.0	86.5	Excellent
75	25	150-170°C. 10 Min.	Good	110.5	115.0	Excellent
66⅔	33⅓	180°C. 15 Min.	Good	114.5	117.5	Excellent
50	50	200°C 15 Min. (darkened)	Good	129.0	134.5	Excellent

The electrical properties of ethyl cellulose compared with other cellulose derivatives are given in the following table:

	Dielectric Constant 1000 Cycles	Power Factor %	Dielectric Strength Volts per Mil	Specific Surface Resistivity Ohms x 10^{-16}
Ethyl Cellulose	3.9	0.25	1530	2,000
Benzyl Cellulose	3.4	0.24	2200	10,000
Cellulose Acetate	5.7-7.0	0.50	1400	15

The tensile strength of ethyl cellulose and its elongation are compared with other cellulose derivatives in the following table:

	Breaking Strength Kg./Sq. Cm.	Elongation %
Ethyl Cellulose	300-500	10-15
Benzyl Cellulose	350-375	18-20
Nitrocellulose	550-700	4-6
Cellulose Acetate	425-475	6-10

* Manager, Technical Service, Cellulose Products Department, Hercules Powder Co.

1

1. The above forms show the versatility of Plexiglas, an acrylic resin, which can be bent and formed with moderate heat and is available in sheets of different thickness. 2. Windows in the dining room of the Hindenburg, and throughout the ship, are of this transparent material

2

Acrylic resins

BY DR. D. S. FREDERICK*

The rapid growth of synthetic resins as important articles of commerce has in many cases been the result of extensive research in the industrial exploitation of substances known to chemists for many years. The acrylic resins[1] are an example of an interesting class of synthetic resins which have in recent years become available in quantity through such research.

The preparation of acrylic acid was first reported by Redtenbacher in 1843 and in 1877 a polymeric modification was described by Linnemann. It was not until many years later, however, that the industrial possibilities of these materials were given serious consideration. Their industrial development was largely the work of one man, Dr. Otto Röhm, of Darmstadt, Germany. His first interest in these resins was acquired through his researches on the acrylic esters with von Pechmann, which were published in 1901. This interest was maintained, and even enlarged, throughout a long and active industrial career, and finally culminated in the manufacture of acrylic resins on a commercial scale for the first time. In 1931 the acrylic resins were first prepared in this country in significant quantity. Since that time their commercial development has progressed rapidly, due to an extension of the variety of available forms and to the numerous uses developed for them.

The acrylic resins are outstanding in their colorless transparency, excellent adhesion to most surfaces, unusual elasticity, and their chemical resistance to many reagents. Since the polymers are relatively unaffected by the action of heat, light and oxidizing agents, they retain these properties indefinitely. The acrylic polymers range from soft, sticky, semi-liquids to hard, tough, thermoplastic solids. Almost any desired degree of softness or hardness between these limits can be made available by the proper modifications during their manufacture. The acrylic polymers have the advantage over other resins in that these various grades may be attained without the use of plasticizers and are, therefore, permanent.

Although an organic glass has been a much discussed hypothetical material, its actual realization was not approached until the advent of the acrylic resins. There is now available a new thermoplastic polymer of an acrylic derivative which has the appearance of ordinary glass and at the same time retains the properties of a synthetic organic resin. It is a colorless, transparent solid with the following properties:[2]

(Continued on page 108)

Light Transmission	
Visible range	94-94.5%
Ultra Violet (1800-3200 A°)	50-70%
Refractive Index	1.49
Specific Gravity	1.18
Hardness	
Mohs	2-3

[2] Refers to Plexiglas.

* Röhm & Haas Company.

[1] Manufactured and marketed under the trade names Plexigum, Plexiglas, Acryloid and Acrysol, Reg. U. S. Pat. Office. Acryloid and Acrysol are marketed under license for the coating of surfaces by the Resinous Products and Chemical Co., Inc.

Editor's Note—A material of similar clarity is being made by du Pont under the trade name of Pontalite.

The Gem of Modern Industry

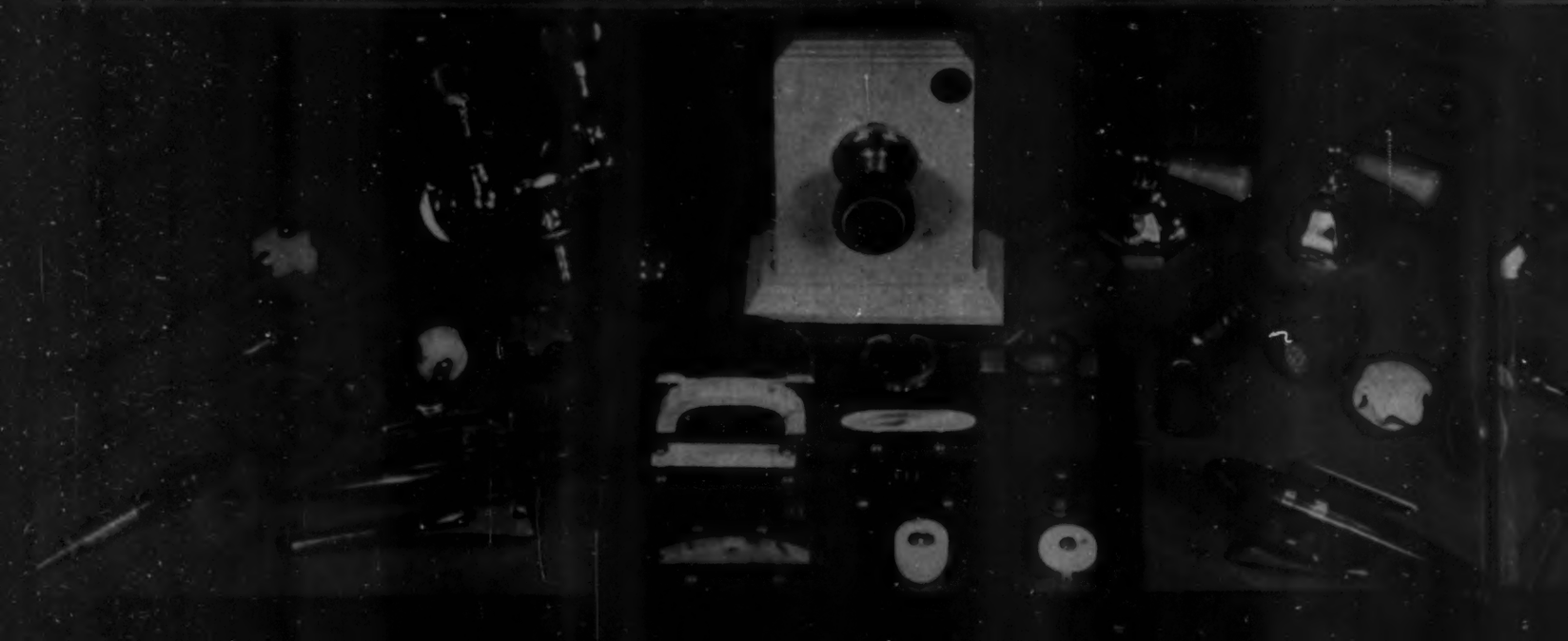
"Beautiful and durable material is not made by chance nor at small expense. Unswerving excellence of workmanship is the surest foundation upon which the leaders of Industry are built. And the world profits by this mutual advantage to maker and user."

—John Ruskin

CATALIN is indeed "The Gem of Modern Industry." It combines the sparkle and luster of a precious stone with the toughness and strength of metal. Its phenomenal rise in industry is not only due to its exquisite beauty, depth and charm of colors, but more so to its practical characteristics and its ready adaption to an infinite variety of uses.

CATALIN, a cast resin, is furnished in solid form such as rods, sheets, tubes or special castings. Unlike other plastic materials, it requires no expensive molds or seasoning. It is ready for immediate use and can be handled with standard machinery and equipment. It is non-inflammable, odorless, tasteless, non-porous, practically moisture proof, resists alcohol, oils and all common acids. It has a high dielectric, tensile and compressive strength and holds its shape and color without deterioration.

Color, Beauty AND Texture



CREATE Catalin SALES APPEAL

Ease of Application AND SIMPLICITY OF HANDLING CREATE NEW OPPORTUNITIES FOR THE MANUFACTURER

•

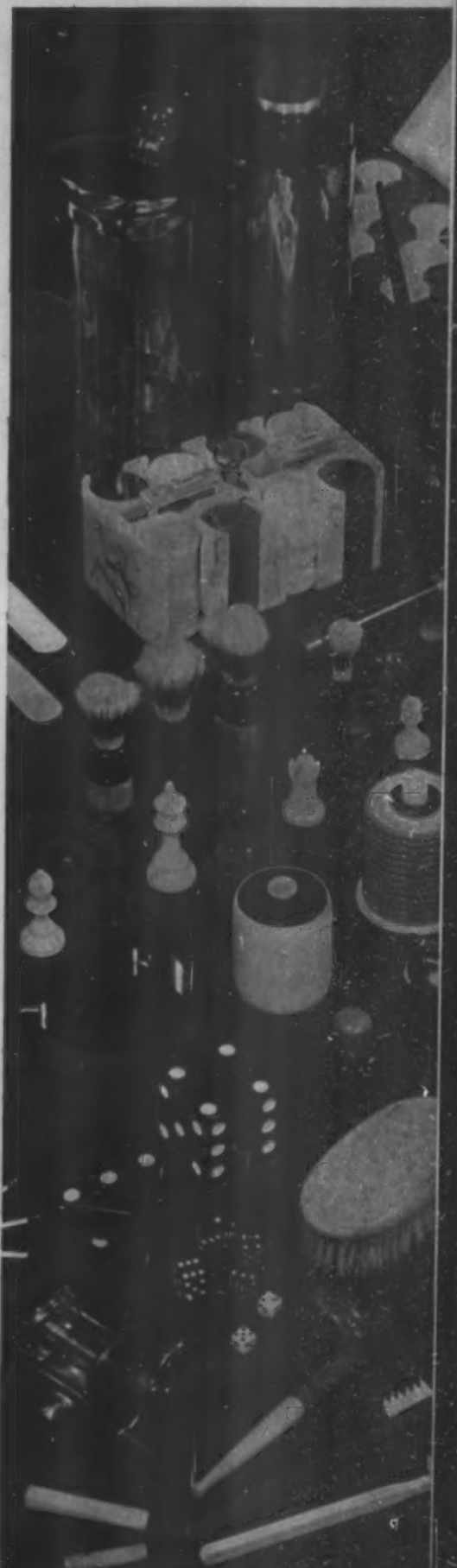
The collection of finished products as shown in natural color photography illustrates only a small part of the variety of uses to which CATALIN can be successfully applied. Combined, they represent the use of many thousands of tons of CATALIN distributed over an ever increasing number of manufactured products in diversified lines.

Gem-like, CATALIN colors go clear through, showing the subtle sparkling of Emerald, the lustrous Black of Ebony, the brilliancy and transparency of a precious stone and the many tints of modern pastel colors, either opaque, translucent or transparent, in plain, mottled or grained effects. New colors can be created to suit modern trends.

Contributing largely to the rapid adaptation of this most beautiful plastic material is the fact that it can be used readily for new applications without the necessity of expensive molds and patterns. It lends itself ideally to any change in style, design, color or shape. Shipment of the finished material can be made within ten days after a design has been approved.

CATALIN encourages experimentation because it is furnished in solid form ready for use, similarly to iron or wood. No special machinery or equipment is necessary. The manufacturing operations are simple, i.e., CATALIN can be readily turned, threaded, drilled, cemented and carved to suit conditions. It combines perfectly with other materials and creates new and original effects.

The magic of color combined with attractive design improves any product. It stimulates sales, attracts buyers and creates larger distribution in new channels of trade. Modern business demands beauty in luxuries as well as in the necessities of life. The rich, sparkling, warm and deep colors of CATALIN and its ease of adaptation for many purposes make it an ideal material to be applied readily and inexpensively.



SERVICE

For your convenience we maintain in our offices an interesting exhibit of finished products which are manufactured wholly or partly from CATALIN. This display clearly shows the universal application of our material and its possibilities in connection with your own problems.

We also maintain a stock room in which we have ready for immediate delivery the largest variety of colors, shapes and sizes. This service will enable you to experiment and conduct your own test without delay.

Although we do not manufacture any finished parts, we operate a sample fabricating shop, showing the essential fabricating equipment in actual operation. This not only enables us to produce samples of any application in which you may be interested, but it also makes it possible for you to clearly visualize the ease with which our material can be converted into your finished product.

CATALIN has assisted many manufacturers in the creation of new items. It is our hope that we may also have the privilege of serving you.

Catalin

AMERICAN CATALIN CORPORATION

ONE PARK AVENUE • • NEW YORK, N. Y.

Furfural-phenol resins

BY E. E. NOVOTNY *

The commercial value of phenol-furfural resins was definitely evaluated prior to 1920, but unfortunately furfural was then selling at thirty-five dollars per pound and this price had to be brought down to an economic basis before its use was practical commercially. Through cooperation with the United States Department of Agriculture, The Quaker Oats Company, and its associate, The Miner Laboratories, this was realized. As the product is produced from annual growths of waste farm cellulosic materials containing pentosans, such as oat hulls, corn cobs, rice hulls, peanut shells, etc., and as the manufacture of furfural is a relatively simple decomposition and extraction method it is expected that the price of furfural will eventually be still lower and that it will be available in unlimited quantities.

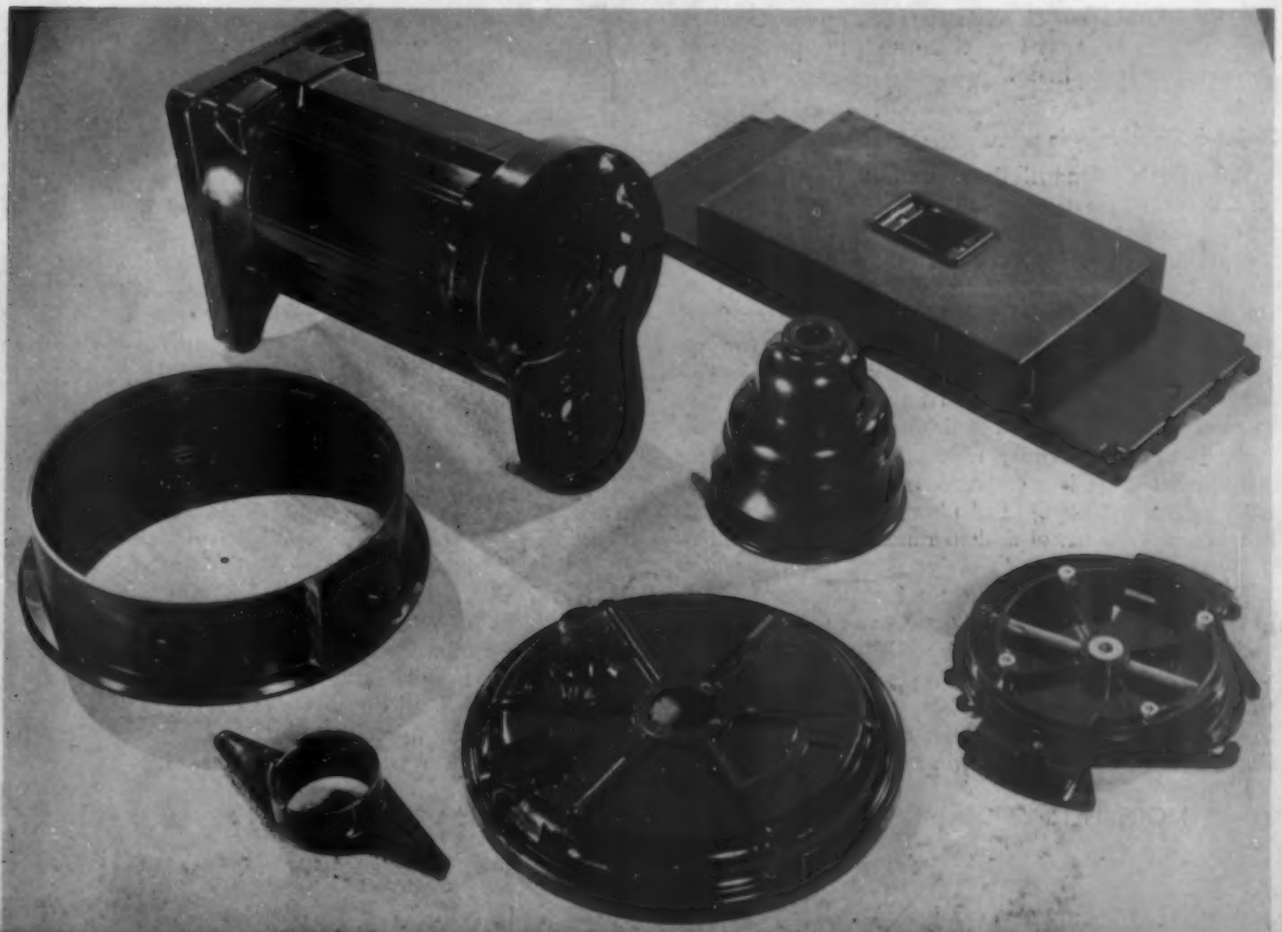
Furfural resins are the result of deliberate research having in view certain characteristics lacking in other synthetic resins. Our manufacture of printing plates initiated these requirements and it was then found that these furfural resins were ideally suited for use in molding compounds and as a bond for diversified types of plastic molding.

Unusual properties

Phenol-furfural resins have exceptional properties such as a long drawn out and flat plasticity curve at preliminary heating temperatures with little or no polymerization or heat hardening taking place and a very rapid and almost vertical final polymerization or curing curve at temperatures exceeding 320° F. These properties alone from the standpoint of either cold or heat and pressure molding greatly increase the scope of moldability as the product reacts quickly to an infusible, insoluble solid substantially as soon as the temperature reaches 330° F. within the mass. This is so because there are less phenolic (OH) groups to be inactivated in the final cure. A phenol-furfural resin contains fully three times the amount of reactive aldehyde which would be present in a resin utilizing an aldehyde of lower molecular weight and, furthermore, the furfural itself is capable of resinification and therefore an excess may be used and the result is reflected in a molded piece which is rigid when ejected from the heated mold. Being devoid of the usual rubbery characteristics the molded part retains the shape of the mold cavity with greater dimensional accuracy, is not as likely to warp or blister, and the surface of the finished piece even when ejected from a hot mold reflects the surface of the cavity. In addition to its moldability and retention of its molded shape, the product is strong and tough and displays less thermoplasticity upon subsequent reheating and stands up well under repeated shocks as in a riveting operation. While the color of the phenol-furfural resin is naturally either brown or black, less pigmentation or

* General Manager and Director of Research, Durite Plastics.

A group of parts molded from furfural showing diversified use of the material



DURITE

Another group of furfural molded objects further illustrating its wide range of application

toning is needed to bring up the proper color and since the largest demand for molded parts is in black or brown color, the natural color of the product is uniform throughout the piece and will withstand sunlight and ultra-violet light with less color change due to this permanent inherent color and to the relative freedom from uncombined phenol. As less phenol is used and an excess of furfural can be utilized, the product by this simple means is readily available for use as a molded part closely adjacent to photosensitive films which are easily fogged through the presence of an excess of free phenol.

Furfural the aldehyde

Furfural is substantially water free, thus providing an anhydrous reaction with the exception of approximately 18 lbs. of synthetic water formed in a reaction comprising 100 lbs. each of phenol and furfural. This water is liberated and removed by separation as quickly as formed and the balance of the furfural combines with the remaining phenol to produce approximately 182 lbs. of resin. While this is an economic gain, the important advantage is the fact that the amount of phenol required per unit weight of resin is very materially reduced or perhaps better stated, that there is more reactive aldehyde combined with a given unit weight of phenol to promote resinification of the phenol and to render the resin potentially reactive.

Furfural is, however, most advantageous because of its peculiar chemical attributes. When these unique and conglomerate attributes are skillfully combined in a phenol resin the resultant resin must have exceptional qualities. As to these unique attributes we have in the furfural molecule at least three distinct functions, that is, first an aldehyde radical, second a reactive heterocyclic structure and third a system of conjugated double bonds. There are other resinification functions, but for the purpose of this article it may be stated that at least these three combine in the structure of a phenol-furfural resin.

Furfural resinification

Furfural alone in the presence of a suitable catalyst will resinify through a liquid resin phase to a solid infusible resin. This may be carried out with or without external heating and the resin is strong, tough, resilient and is resistant to repeated blows and shocks. By so regulating the reaction through the use of heat and suitable catalysis the reaction may be stopped at any given point to provide liquid resins having various viscosities, but unfortunately there is no well defined solid fusible stage in a resin made of furfural alone and therefore this product while useful for casting purposes is not ordinarily useful for pressure molding except through the use of modifying agents.

This furfural liquid resin may be utilized in numerous hot and cold molding processes, as a wetting agent for the filler or solid ingredient, and as one form of modification to this may then be added other resins more solid and higher in melting point, such as fusible pulverized potentially reactive resins, and a molding composition made therefrom which is utilizable in either hot or cold molding. With furfural so able to resinify within itself we can readily understand why furfural the aldehyde should have such useful attributes as a resinification promoting agent with phenol to produce a liquid or solid soluble or fusible resin having long keeping qualities, well defined plasticity and above all one that is capable of most thoroughly and completely resinifying under elevated curing temperatures.

Furfural-phenol reaction

Furfural and phenol combine on an equal molar basis, that is 96 parts by weight of furfural with 94 parts by weight of phenol, thus less phenol is present in a given unit weight of resin and there are less phenolic (OH) groups to be inactivated. In phenol-aldehyde resinification the ultimate conversion of a reactive resin has to do with the inactivation of the phenolic (OH) groups present in the product. In the phenol-furfural resin there are less phenolic (OH) groups introduced to start with and quantitatively there are less phenolic (OH) groups to inactivate throughout the resinification cycle including both the initial and final resinification stages. We have found that a solid fusible "A" stage phenol-aldehyde resin will have somewhat less than fifty per cent of the initial phenolic (OH) groups inactivated and that the final cure requires that as much as possible of the balance of these groups must be inactivated during the final curing cycle. With furfural itself capable of resinification and its combining ratio such as to require less phenol these phenolic groups are in the minority, the aldehyde groups in the majority, and therefore the final cure is more complete.

Furfural, a hardening agent for phenol resins at curing temperatures, a powerful resin solvent even at room temperatures, is functionally unique in that plasticity during the molding operation is increased, the rate of heat setting during the curing operation is likewise increased and any excess of free furfural resinifies to a furfural resin. Thus with furfural within the resin structure we have a molding plasticizer and hardening agent and a resinifying agent encompassed within the one material.

The finally cured product may be considered as consisting of a network of thoroughly interlaced, cross linked molecular chains of various dimensions and types with the diversity of types directly due to the many fold character of the furfural reactions. The hardening ability of the fusible resins is constitutionally due to their potential capacity to undergo further ring closures and cross linkages. Heterogeneity in structure is responsible for the excellent impact strengths and for the long drawn out flat plastic curve of these resins. The substantial irreversibility of the reactions as well as the relative water insolubility of furfural to begin with and continually reflected through the intermediate stages of resinification to the final ultimate resinification products is responsible for the great physical strength, chemical inertness and water resistance as well as the resistance towards disintegrating forces. It is the conglomerate nature of furfural which provides such fully cured pieces which are rigid when ejected from the mold, which retain the polish of the mold and which are free from sticking and staining of the mold.

Colors

The natural brown and black color of these phenol-furfural resins ordinarily prohibits their use where light pastel shades are indicated, but so far as the solid darker colors are concerned it is a simple matter to produce such colors as red, brown, green, yellow, etc., and beautiful permanent mahogany, walnut and oak colors and blends are easily obtained. While this article pertains itself to phenol-furfural resins which are naturally brown and black, the urea-furfural resins are considerably lighter in color and there are modifications suitable for light pastel shades.

Properties

Some of the exceptional properties of phenol-furfural resins are enumerated below.[1]

1. The resins are uniform in melting and fusion points, the reactivity of the product is very low at rolling and compounding temperatures, thus the control from batch to batch of molding material is easily maintained within close tolerances.

2. The resin and molding compound have long keeping qualities. Even at summer heat there is no material reaction sufficient to raise the melting point or retard the flow characteristics of the composition.

3. Compounding and roll temperatures due to the plastic nature of the resin promote the production of uniform mixtures, with the filler well covered, with great ease and uniform control of product. The spread of these furfural resins at the temperature of rolling is such as to promote fusion and plasticity insuring thorough covering of fillers. The resin is ideally plastic for manipulation on differential rolls as the composition clings to the rolls even though a relatively large amount of filler is used. Thus it is possible to incorporate fillers for the purpose of modifying the properties of the resin or to introduce a small amount of resin in a large amount of filler by utilizing the bonding properties of the resin. This compounding is accomplished without objectionable heat hardening or polymerization and it is for this reason also that most any proportion of filler may be incorporated to provide a composition having the characteristics desired for the particular part which is to be molded. Compounds for cold molding are also easily made.

4. The molding compound may be produced in sheets and the sheets may be comminuted or a mere mixture or blend of comminuted materials may be produced. The product preforms into a firm tablet.

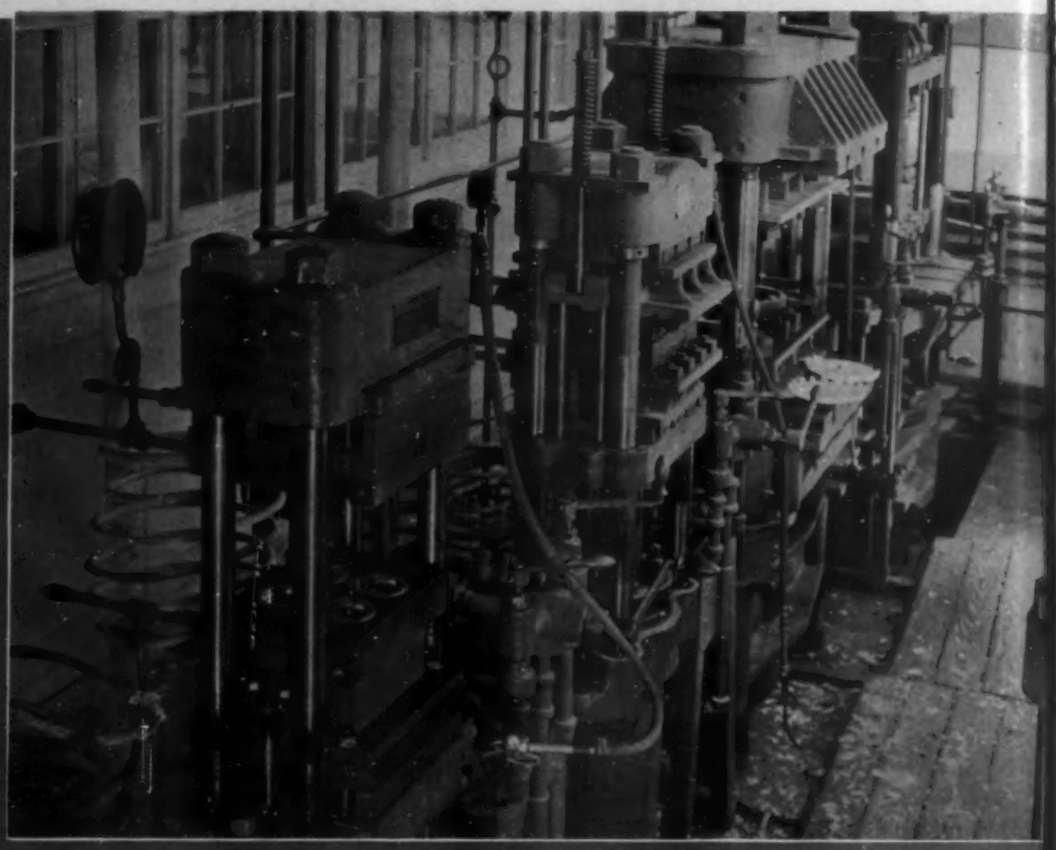
5. The molding composition when pressed into difficult shapes and sizes flows into and fills out the mold cavity thus producing a perfect replica of such cavity even to the smallest detail of mold finish. This moldability does not call upon minute adjustments of cut off edge in a flash type mold nor a study of closure time in order to insure the proper filling of the mold cavity. The pressure within the mold cavity is substantially hydrostatic in that the composition has a free but restricted flow.

6. Relatively large thin pieces such as wall plates and spool flanges leave the mold rigid and are relatively free from warpage. This is due to the fact that furfural resins harden completely. Printing plates as large as those of metropolitan daily papers have been molded of Durite furfural resins, without side flow confinement and removed from fragile composition matrices while hot with substantially no warpage nor loss of surface finish. Radio tube bases having thin side walls do not become concave, and thus provide a uniform depth of imprint for the steel branding tool. Stated otherwise, the pieces ejected from the hot mold substantially retain their *(Continued on page 106)*

[1] These properties are based upon Durite.

BEETLE IS UNIFORM

it's checked by rigid tests!



A battery of molding presses, shown above, checks the flowing properties of Beetle under actual working conditions. At left are shown (top) a spectro-photometer for complete color analysis and (below) a corner of the analytical laboratory where Beetle is tested and retested at each step in the production cycle.

IF you could follow the course of a batch of Beetle molding material as it goes through production, you'd be tempted to say we go to extremes in testing. Perhaps we do. But when you specify Beetle you can be sure your material will meet even more rigid standards than you yourself demand. Uniformity in strength, color and texture are *musts* in Beetle—and the extra long and satisfactory service that Beetle gives is justification enough for the strict care we take in its production.

Tests are made of the raw materials both before and after mixing. The mixture is rechecked after drying and again after grinding to powder. Following the addition of pigments it is tested photometrically for color, pigment distribution, reflection, transmission, intensity and opacity. Every batch or shade is given a complete spectrum analysis.

Then, on the machines you see above, Beetle is given the final "works." Under *your* actual working conditions it must measure up to *ideal* molding standards — in tests for uniformity, texture, flow, color and strength.

Is so much testing necessary? Yes, we say. For it is this rigid system which gives Beetle its superior working properties and which has established Beetle as a pioneer name in the field of molded products. It is your guarantee of uniform quality.

BEETLE PRODUCTS DIVISION OF AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

Beetle

IT'S ALL COLOR AND IN ALL COLORS

Cumarone resin

THE position of Cumar* as a thermoplastic material in the organic resin industry requires a brief clarification of terms. The rapidly accelerating, plainly evident growth of the industry has brought much of its nomenclature into common use. The terms thermoplastic resin and thermo-setting resin are most familiar, but the industry has advanced and expanded so far, that the significant difference indicated by the terms is now of decreased importance. We will, however, continue to classify natural and organic resins under such obvious headings.

Recently a technical argument has been made that all resins are thermoplastic. It is reasoned that those which are called thermo-setting appear so only because they decompose or dissociate below their softening points. Other technical qualifications and various devices of logic further cloud the issue, until one realizes that the area is vague in which thermoplastic ends and thermo-setting begins.

The generalization that the commercial use of a resin depends on its thermoplastic or thermo-setting property is too broad for the business of today. Both types are being modified constantly to meet new conditions and new uses,—thermo-setting resins are now being blended with plasticizing, or flexibilizing agents so that infusibility cannot occur. In some cases radical changes in formulas and manufacturing processes are introduced to obtain the same end. Thermo-setting may or may not be desirable.

On the other side, modified thermoplastic resins are now being produced with higher softening points, diminished temperature susceptibilities, higher viscosities and other features which cause them to approach closely to the thermo-setting type. Then, too, there have been marked advances in the more intelligent use of individual resins. Manufacturers desiring specific properties or improved costs have changed a process or design to permit utilization of resin in ways which formerly had been considered impossible.

The paracoumarone-paraindene resins stand as examples of important thermoplastic resins. They may be obtained from crude coal tar naphthas in the approximate boiling range of 150-200°C. The methods of treating and polymerizing the resin forming constituents, with subsequent refining of the resins have been widely published here and abroad. Perhaps the most comprehensive single investigation on the theoretical aspects of the resinification process is that of Staudinger and his pupils. Whether one agrees, or not, with all of Staudinger's work, the fact remains that he has drawn a very detailed picture.

Cumar,* a trade-marked name under which such resins are sold, covers a scientifically controlled, closely specified series of resins whose development and manufacture has extended over more than twenty years. This resin is supplied for use in many fields where its properties meet special requirements. The two broad lines along which it is graded commercially are color and softening point.

These resins range from a very faint yellow to darker colors. In softening point, the present commercial range is from 10 deg. C. to 160 deg. C., liquids, viscous products, solids. Some of the solid forms are shipped as flakes, or chips to facilitate utilization. Fairly wide variations in the viscosity of the fluid resin can now be produced. As in other fields, economics is the controlling factor in determining actual grades of commercial production.

Being essentially a polymerized hydrocarbon, this resin is to be considered as a neutral, stable resin. It is insoluble in water. It is not saponified or dissolved by alkalis. It has good acid resistance. It may be dissolved in a variety of organic solvents,—benzol, toluol, and many others. It is durable to weathering actions. In addition to its great variety of specialty uses, it has long since become an important material in many major industries.

The use of this resin as a binder in floor tile is a natural application. Being light in color, it permits the manufacture of brighter, light colored tile. Resisting saponification, it is unaffected by soap or cleaning compounds. Water does not affect it. Being resistant to weather and abrasion a long tile life is assured. Its use in chewing gum is important. It is compatible with the constituents of chewing gum and the grade used has no objectionable odor or taste. The compound, in flexibility and insolubility, meets all chewing gum requirements.

This resin is an important constituent in rubber compounding. It blends well with rubber, greatly facilitating milling operations. Depending on the grade and amount employed, as well as on the method of use, a variety of useful properties can be imparted to rubber products. The electrical resistance of this resin is excellent. After long submersion in water, power factor determinations show little, if any, change in value. Such properties recommend it for electrical insulation service where power losses must be cut to a minimum,—as in radio and television equipment.

The value of cumarone resin in varnishes is evident. It is unaffected by alkali, weather resistant and neutral, and therefore especially suitable for aluminum paint formulation. Its non oil-reactivity with drying oils gives it a definite place in the formulation of varnishes. It facilitates cooking and cooling operations, especially when the varnishes are made with china wood oil. The non-reactive resin can be employed to check or modify reactions set up when other resins are being cooked in, or when the oil itself is bodied. In printing ink varnish, it has also earned and maintained a definite place. Road marking paints containing this resin have stood up well, even under the most severe traffic conditions.

The adhesive industry has many ramifications in which it now has a part. That this is so is due to several factors,—the chemical stability, its resistance to decomposition caused by bacterial or fungicidal action, its permanent compatibility with the balancing constituents of the adhesives. In most adhesives where fixing by heat is required, its stability is noteworthy, as the resin is not (*Continued on page 105*)

* Reg. U. S. Patent Off

Polystyrene

BY O. H. SMITH *

STYRENE is a colorless liquid boiling at 146 deg. C. and having a density of .925. It is readily converted into solid polystyrene by heating, with or without catalysts. The density of polystyrene is 1.054. The marked change in volume which occurs during polymerization is a factor to be considered in forming objects by casting. Styrene will polymerize slowly even at room temperatures, especially if it is exposed to sunlight, but can be kept indefinitely in a liquid condition in the presence of a very small proportion of a suitable inhibitor. Its polymerization is markedly accelerated by organic peroxides like benzoyl peroxide and by inorganic compounds such as aluminum chloride, stannic chloride, and sulfuric acid.

The physical properties of polystyrene are largely determined by the conditions of polymerization. It may be extremely tough or may be very brittle. The color may vary from colorless to yellow, or even brown. The colorless product cannot be obtained unless air is rigidly excluded during polymerization. Catalysts usually produce polystyrene of poor quality. The quality is not materially affected by the presence of solvents during polymerization if a suitable minimum concentration of styrene is maintained. This fact is important practically as it adds to the convenience of handling during the manufacturing operation. It is now generally recognized that the strength of polystyrene and its viscosity in solution are directly proportional to its molecular weight and it is sometimes assumed that these properties can be controlled by varying the time of heating. This is not a fact. Polystyrene which is formed during the early stages of polymerization does not differ materially from that formed in the final stages. The lengths of the chains are determined by factors such as temperature, concentration of styrene, and the proportion of air or catalyst which is present and not by the time of heating. However, there may be a difference in solubility if impurities which promote cross linkage are present. A mere trace of divinyl benzene will produce a noticeable difference in solubility. If it were not for the possibilities of such impurities being present during polymerization, the strength of the polymer could be determined by measuring its viscosity in solution.

Polystyrene is one of the oldest synthetic resins but its development has lagged far behind resins of less merit due to lack of suitable manufacturing methods. When the development of the domestic material was begun no method was known by which styrene could be produced at a reasonable cost. Equally important, no method was known by which it could be polymerized to produce resin of uniformly good physical properties. Now, however, practical methods of production have been developed both in the United States and Europe.[1]

Styrene can be produced in the laboratory by a variety of methods, but ethyl benzene is the most satisfactory starting material for producing it practically. Styrene is produced by removing two hydrogen atoms from ethyl benzene, either by pyrogenic dehydrogenation or by chlorinating and removing hydrochloric acid subsequently.

* In charge of Polystyrene development with U. S. Rubber Products, Inc.

[1] Polystyrene of domestic origin is sold under the trade name "Victron" made by Naugatuck Chemical Company. A denture material with Victron base is sold under the trade name "Marvelyn", made by Marvelyn Dental Corporation. Polystyrene of foreign origin is sold under the trade names "Resoglaz" imported by Advance Solvents and Chemicals Corporation and "Trolitul", made by I. G. Farbeinindustrie A. G., respectively.

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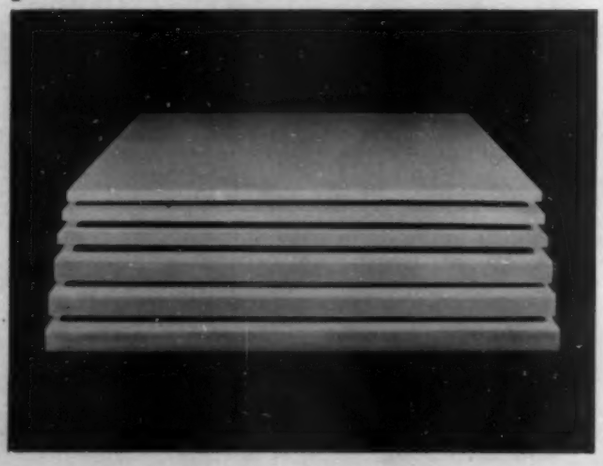
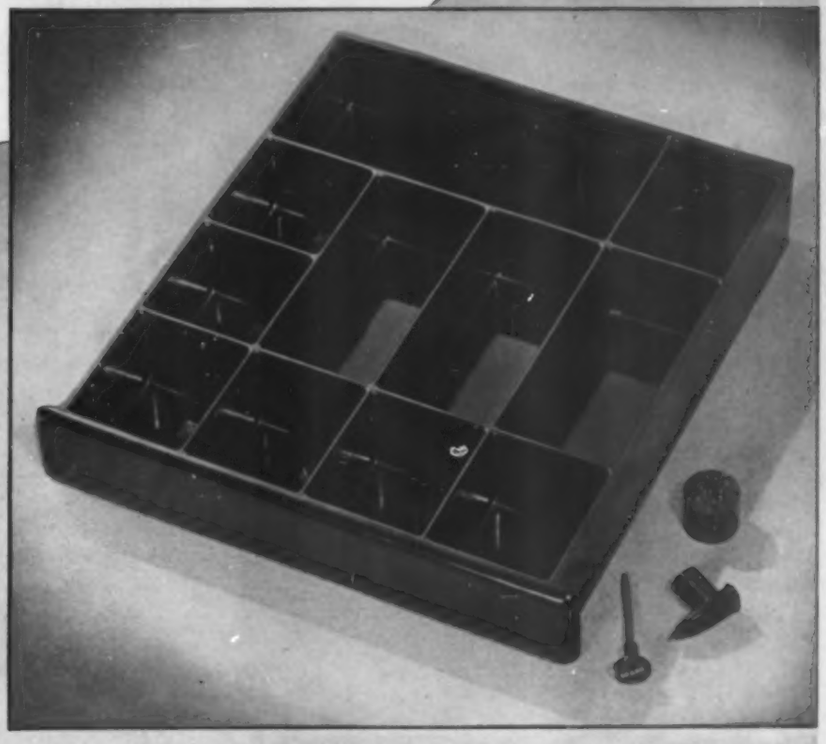


1. Denture plate of Marvelyn, a styrene product, shown through the courtesy of the Marvelyn Dental Co. 2. Sheets of styrene as used by Communication Products, Inc., in its radio work

Plastics by

DURITE



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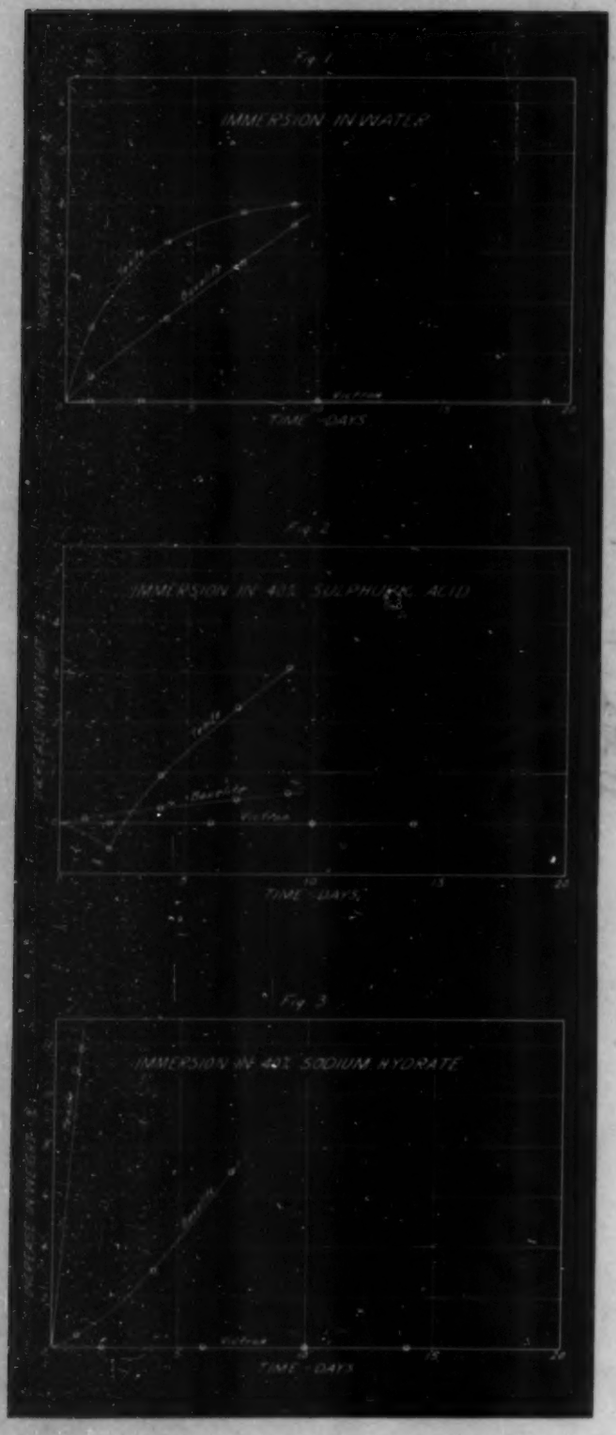
Polystyrene



Samples used in test were usual grades for radio work and contained no inorganic filler

Ethyl benzene is manufactured by combining either ethyl chloride or ethylene gas with benzol in the presence of aluminum chloride. Its manufacture was a considerable problem in itself during the early stages of the development of styrene as it had not been produced previously on a commercial scale. Polystyrene is readily shaped by the application of heat and pressure and can be molded directly from the powder. It is a true thermoplastic and is not affected by continued heating at molding temperatures. It is highly inert chemically and possesses remarkable insulating properties. These merits are common to both brittle and tough polystyrene and also to the so-called insoluble polystyrene which is formed by the cross linkage of polystyrene chains with divinyl benzene.

Fused quartz is considered by many engineers to be the ultimate in radio frequency insulation. Polystyrene is fully as good as fused quartz with reference to dielectric losses, is definitely superior to the usual commercial ceramic insulators and is vastly superior to any other resinous insulating material. It may be regarded as loss free from a practical point of view. Its dielectric constant is 2.96 and its power factor at 1,000 kilocycles is approximately .022 per cent. The loss factor may be given as the product of the dielectric constant and the power factor in per cent. Accordingly, the loss factor of polystyrene is approximately .065. The power factor of transparent fused quartz is about .02 per cent, but its dielectric constant is in the neighborhood of 3.7 so that its loss factor is actually higher than that of polystyrene. Compared to the loss factors of other resinous materials, that of polystyrene is negligible. Its loss factor does not change with moderate changes in temperature. The loss factor of a comercial sample of Victron was found to be .065 both at 25 deg. C. and at 75 deg. C. respectively.

The dielectric strength of a commercial sample of the American product has been found to be 517 volts per mil at 60 cycles using a sheet 1/8 inch thick. Sheets of the same material .030 inch thick have withstood a voltage of 1500 volts per mil without being punctured.

Polystyrene offers many advantages as a hardening and an adhesive promoting medium for waxes and a base for low loss varnishes and lacquers. It is being used in increasing quantities for these purposes. Polystyrene is highly resistant to most chemical reagents; it is entirely unaffected by water and alcohols and by most acids and bases. It has been used practically at moderate temperatures over periods of more than a year, in the presence of strong sulphuric acid, acetic acid, sodium hydrate and alcohol without being affected. It is not recommended for use in the presence of strong nitric acid. It does not age in diffused light over a wide range of temperatures. Its surface is slightly yellowed in direct sunlight. This is merely a surface effect and is due to oxidation, sunlight acting as a catalyst. If air is excluded from the polystyrene by pressing it between glass, it can be exposed to direct sunlight for years without being affected. Surface oxidation occurs slowly in the absence of sunlight and only if the polystyrene is heated above its softening point in the presence of air. It can be exposed to air for an indefinite period at temperatures below approximately 60 deg. C. without being affected. Figures 1, 2 and 3 illustrate the behavior of the commercial product in water, acid and base respectively, in comparison with a sample of phenolic and one of acetate.

Polystyrene has a softening point of approximately 90 deg. C. It might be better to say that the softening point of tough polystyrene is about 10 deg. higher than that of the usual hard rubber, as the determination of softening point may be an uncertain factor

Apart from the remarkable increase in the use of Plaskon for hundreds of different products, 1936's most significant trend has been the use of Plaskon in molding large mechanical housings, jars, and lighting and electrical equipment of all kinds. The Toledo Scale and Enterprise Meat Chopper housings, Colt's featherweight cosmetic jars and the Wakefield and Miller reflectors are examples of the practicability and profit of major new plastic developments.

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MANICURE MACHINES

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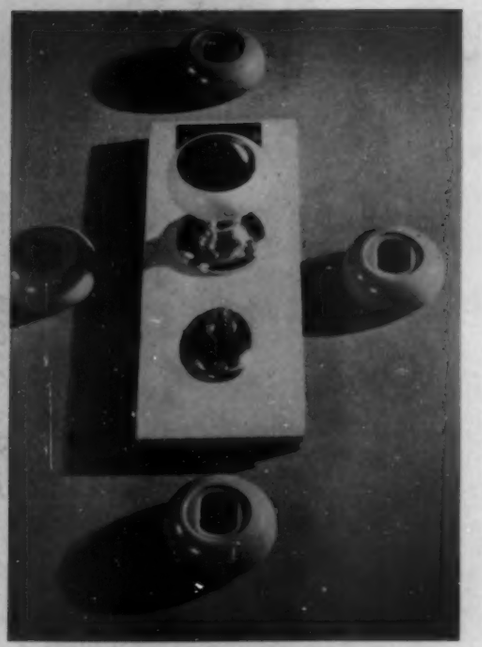

LOCKWOOD DOOR KNOBS

MICRO-LITE FLASHLIGHTS

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COLT'S COSMETIC JARS

AUTOMOBILE FITTINGS

OLD DUTCH CLEANSER

ENTERPRISE MEAT CHOPPER

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GRUEN WATCH

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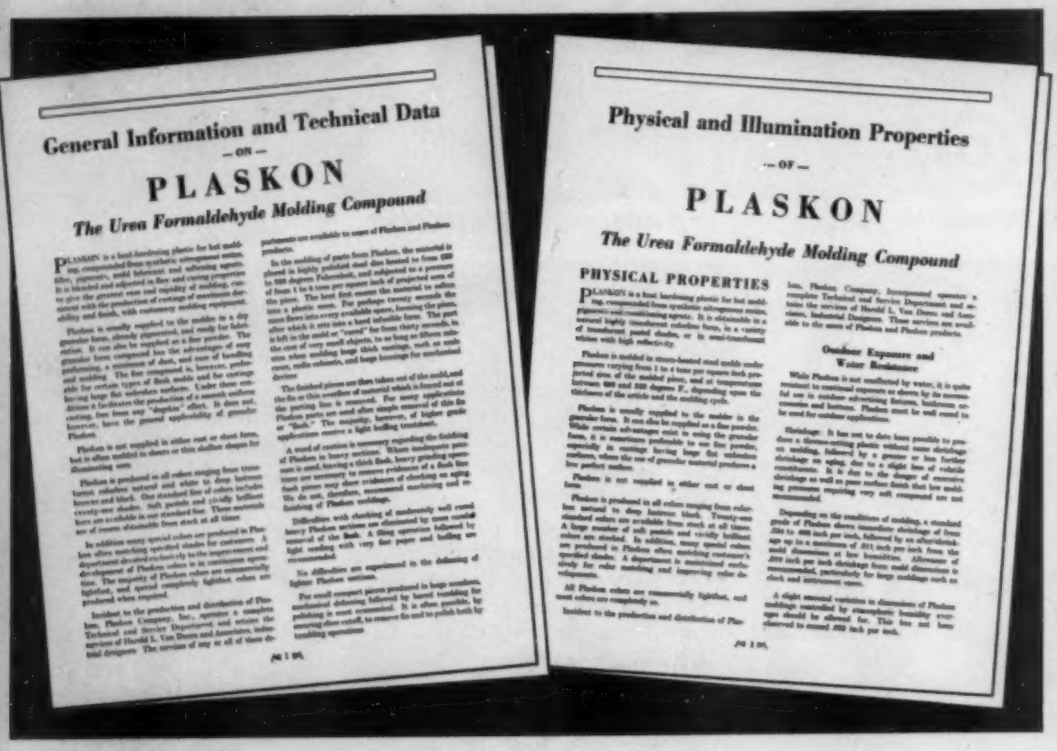

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at best. The brittle variety of polystyrene softens at a lower temperature. Molded polystyrene does not actually lose its shape without the application of external stress until a temperature of approximately 110 deg. C. is reached. Above 110 deg. C. it assumes a rubbery form, becoming progressively softer as the temperature is raised. It can be melted to a fluid state without chemical change at approximately 250 deg. C. if air is rigidly excluded. In the presence of air at this temperature it is rapidly oxidized, forming a brown, very brittle product. It is readily decomposed, largely into liquid styrene and distyrene, at temperatures much above 300 deg. C. The latter reaction offers a convenient means of obtaining liquid styrene in the laboratory. Polystyrene is not inflammable but will burn if properly ignited. It burns less readily than hard rubber.

Polystyrene can be easily molded at temperatures between 145 and 160 deg. C. and pressures between 500 and 1000 pounds per square inch. Both temperature and pressure can be varied rather widely without harmful effects. Objects which are molded from polystyrene have almost exactly the same dimensions as the mold providing they are chilled below 60 deg. C. before being removed. Polystyrene is not affected by continued heating below 200 deg. C. This fact makes it an attractive material for injection molding.

Molded polystyrene is extremely tough and strong, the transverse breaking strength of the commercial American product lying between 10,000 and 12,000 pounds per square inch. However, it will break somewhat like glass if stressed beyond its elastic limit. This glass-like structure can be largely eliminated by the addition of comparatively small amounts of suitable plasticizers. Plasticizing materials which do not affect the dielectric properties are available for this purpose.

Molded polystyrene can be machined without difficulty. Sharp coarse tools with adequate rake should be used. The work should be kept cool to prevent gumming. Water is the best lubricant. Pure mineral oil is not objectionable but poor or partly decomposed oil may contain impurities which affect the strength unfavorably, although the surface and appearance are not noticeably affected. Parts can be securely cemented merely by wetting with solvent and pressing together while still slightly tacky, or the material may be readily fused to itself. Solvents should be used sparingly for cementing. A solution of plasticized polystyrene can be used for this purpose to even better advantage than solvent alone. Polystyrene is soluble in benzol, toluol, xylol, ethyl benzol, ethyl acetate, butyl acetate, carbon tetrachloride, ethylene dichloride, chloroform and similar solvents. It swells in gasoline but does not dissolve. It is not affected by pure mineral oils or vegetable oils but may be weakened by impure or partially decomposed oils.

The ease with which polystyrene can be dissolved in cheap and non-inflammable solvents is of considerable advantage in coloring and filling the material. Colors and fillers can be stirred into a thick solution of the material and the mixture can be dried and ground subsequently. Being colorless and transparent, polystyrene is easy to color. Most of the usual filling materials can be added up to approximately 40 per cent by volume without affecting the strength materially. Obviously, fillers cannot be added to polystyrene without affecting its dielectric properties. No commercially available filler is loss free and materials which actually improve the dielectric properties of other resins have a noticeably unfavorable effect on polystyrene.

Polystyrene moldings of radio parts shown by courtesy Communication Products, Inc.

Polystyrene can be plasticized with a wide variety of materials. Dibutyl phthalate, triphenyl phosphate, tricresyl phosphate, chlorinated diphenyl, and chlorinated naphthalene are only a few of the available materials, but represent the types of plasticizers which can be used. Polystyrene can be plasticized and still retain in large part its excellent dielectric, acid, and alkaline resistant properties. Polystyrene is not compatible with rubber, balata, shellac, cellulose esters or ethers, or polyvinyl acetate. It does not give clear films and moldings with these materials. It is compatible with the cumarone type of resin.

The unusual dielectric properties of polystyrene should insure it an important place in the field of radio frequency insulation. Its strength, low gravity, ease of coloring, absence of taste and odor, and its chemical stability make it suitable for special applications such as dentures, while its high resistance to most chemical reagents should lead to a considerable use of the material in special lacquers and moldings which have to withstand the action of such influences. It is admirably adapted to extrusion molding and should attain a considerable outlet in this field.

Although the present selling price of polystyrene militates against its use in many fields where it might otherwise be of considerable interest, this condition is, fortunately, not a permanent one. The raw materials necessary for its production are available in quantity at a low enough cost so that, now that the difficulties which have been attendant upon the commercial production of polystyrene have been largely eliminated, its production in reasonable volume should result in a very substantial reduction in its cost.

Commercial synthetic rubber

BY J. C. PATRICK*

DUE to the fact that differences of opinion have arisen from time to time as to the correct use of the term *Synthetic Rubber,* it would appear to be desirable for any writer on the subject to preface his remarks by a definition of what he considers the scope of the term. This personal definition may or may not meet with the approval of his readers, but should at least clearly define his standpoint.

Tentatively, a *Synthetic Rubber* may be defined for the purpose of argument as: "A synthetic colloid, capable of at least 200 per cent elongation; which will, if rapidly stretched and released, forcibly retract to substantially its original dimensions and in stretching and retracting exhibit the *Joule effect.* When submitted to X-ray analysis, it displays, when undistorted, the properties of an isotropic liquid, but develops a fiber diagram characteristic of crystalline structure when strongly distorted. It is capable of undergoing a marked decrease in plasticity and increase in toughness and elasticity when heated with suitable accelerating substances."

While very great progress has been made, especially in the last ten or fifteen years, toward the more perfect adaptation of natural rubber to the uses for which its unique physical properties are so outstanding, the somewhat unstable chemical structure and the deteriorating effect of nearly all the non-aqueous solvents are still very serious handicaps.

That natural rubber should be subject to definite and serious limitations is far from surprising when it is considered that the biological evolution of the latex-bearing cells of Hevea brasiliensis, the principal rubber-bearing tree, certainly did not contemplate the elaboration of the ideally perfect raw material from which to fashion a molded rubber soap dish or a gasoline or fuel oil hose.

While the metal worker can choose from a variety of metals and alloys to secure the most suitable material for the job in hand, and the plastic molder can select from a number of different resins the one most nearly conforming to his requirements, the rubber technologist has always had to start with the one basic raw material and alter it to an approximation of his needs. One of the most attractive prospects in the field of synthetic rubber, is the possibility of so varying the raw materials and method of synthesis that a variety of rubber-like substances may be had, each designed to conform fairly closely to the requirements of a particular field, *i. e.,* a *custom built* job may be supplied to the technologist. To a considerable extent this goal is now being achieved.

Any extended reference to the history of the efforts of chemists to synthesize rubber would be beyond the scope of this article. Suffice it to say that the record is long, since at least as early as 1879, G. Bouchardat definitely recognized isoprene as the parent hydrocarbon of rubber and demonstrated that the isoprene obtained from the destructive distillation of natural rubber could undergo polymerization to re-form a rubber-like solid.

This conclusive demonstration that natural rubber is a polymeric derivative of 2-methyl butadiene (isoprene) quite naturally had a powerful influence on the direction of future research toward the synthesis of rubber-like substances; efforts being directed almost exclusively to the preparation and polymerization of butadiene and the various substituted butadienes. Only recently has it been fully realized that "rubber-likeness" is not closely related to chemical formula and that the butadiene skeleton is frequently more of a liability than an asset.

In this connection it is interesting to note that of the three different varieties of synthetic rubber which have received wide commercial application, the two latest arrivals in the field, the American polychloroprene and the German and Russian synthetics, are of the polymerized butadiene type.

While the American product[1] which is a derivative of chloroprene (2-chloro, 1-3 butadiene) has become well known and very complete data concerning its compounding and properties are available, no such reliable information is available, so far as the writer is aware, in the case of either the German or Russian synthetic rubbers.

Both the American[1] and the German[2] products have excellent physical properties, closely approximating those obtained with the best natural rubber compounds. Both are much more resistant to the action of paraffin hydrocarbon oils and gasoline than rubber, but are affected to about (*Continued on page 96*)

* Vice-president, Thiokol Corp.

1. DuPrene. 2. Buna.

This 16 in. synthetic rubber lined fuel unloading hose has been in daily use for over two years. Its inner surface, of synthetic rubber, however, shows no sign of deterioration

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Useful information on other Bakelite Materials appears on pages 239 and 309 of this book.

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THE MATERIAL OF A THOUSAND USES

Shellac, the original thermoplastic

BY WILLIAM H. ZINSSER*

SHELLAC is the most versatile of all the natural resins. Far from the least important of its uses is its application as a thermoplastic in molded compounds and as a binder in which the thermoplastic properties are made use of. As compared with other plastic materials, shellac possesses unusual hardness, toughness, and durability to wear far exceeding substitutes or synthetics of comparative price. Where these qualities are paramount, shellac has not been surpassed or even equalled.

The solubility of the resin in alkalies and in alcohols are points of both strength and weakness since these properties permit cheap and convenient solutions to be prepared, yet the surface of molded products in which shellac is used is affected by these agents. The thermoplastic properties permit it to be re-used and no "seconds" or "scrap" have to be thrown away; yet, unhardened shellac cannot be placed on a hot radiator without warping, or used as a cup for hot liquids. Recent developments point the way to overcoming these limitations and with cheap sources of raw material, the future position of shellac in this field would seem assured.

* President, William Zinsser & Company, Inc.

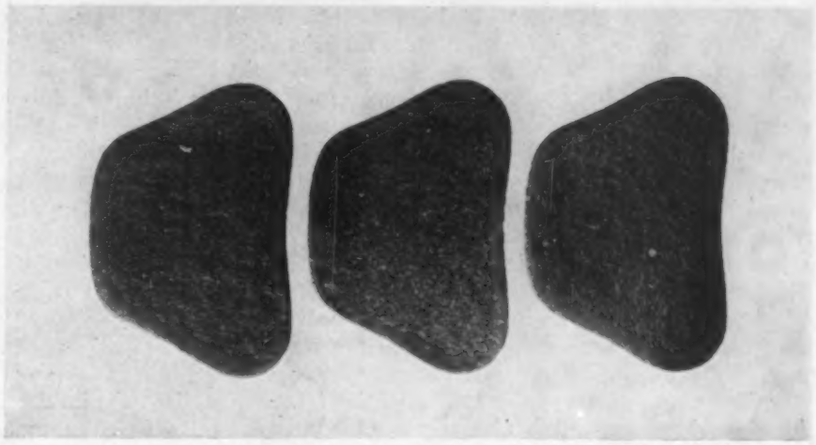
The nature of shellac

Lac resin is the secretion of a small insect which lives on numerous trees in India and adjacent countries to the East. This secretion is collected by the natives and purified by crude native methods which have not changed appreciably for centuries. It is imported into this country generally in the form of thin flakes and called shellac. Within recent years, these ancient processes have been carried out by modern machinery under technical control giving the scientific shellacs which have the advantages of uniformity and cleanliness. About 25 per cent of the total output is produced by mechanical means.

Chemically, shellac resin consists of various hydroxy acids probably partly combined with each other as lactones or anhydrides. In addition to the resin, there is about 5 per cent of natural shellac wax—a hard yellow wax which assists the flow—about 2 per cent of moisture, and from ½ to 3 per cent of dirt, sand and impurities. When shellac is heated to a low or moderate temperature, any volatile matter is given off and further condensation or polymerization of the organic acids takes place. This is accompanied by the splitting off of small amounts of water. The shellac

One well known use of molded shellac is in the production of phonograph records. (Photograph, courtesy William Zinsser & Co.)

Abrasive wheels in which the abrasive material is bonded with shellac under heat and pressure



WILLIAM ZINSSER & CO.

Dental blanks of shellac ready for molding

gradually loses its fluidity, the softening point is raised, and the product finally becomes essentially infusible.

Testing of shellac

Shellac used for molding is generally tested for *fluidity* and for *life*. The so-called Victor flow test for fluidity consists in measuring the distance, through which 2 grams of the resin will flow when heated at 100 deg. C. either in a steam or boiling water bath. A 1-inch by 6-inch glass test tube is used closed with a rubber stopper which is wired in. For 3 minutes the tube is heated in an upright position, then it is tilted at an angle of 15 deg. from the horizontal so that the melted shellac will flow down the side of the tube, after which it is placed horizontally. When cold, the distance through which the shellac has flowed is measured, neglecting any wax "feather" at the tip.

The test for life can be carried out by measuring the time a shellac will remain fluid when worked on a hot plate with a spatula. Another more scientific test is the polymerization test in which a 2 gram sample is heated at exactly 150 deg. C. in a test tube immersed in an oil-bath and the time noted before the sample sets to a rubbery mass.

A good TN orange shellac should have a Victor flow of about 25 to 40 mm. and a superfine grade at least 40 to 50 mm. The polymerization test normally will run about 35 minutes for TN and about 50 minutes for superfine. The scientific shellacs are standardized with respect to fluidity and life and can be obtained on a guaranteed basis.

Bleached shellac is much less frequently used in molding than orange shellac. The bleaching operations always reduce the fluidity and life to a greater or lesser degree and in making bleached shellac for compounding, special precau- *(Continued on page 88)*

Woodflour

BY M. H. FISCHER*

IF THE average person were asked "What is woodflour?" the likelihood of his answering correctly would be slight. Yet the average business man comes in contact with the material in its composite form with other materials many times each day.

Woodflour, as its name implies, is a commodity of wood, pulverized to the consistency of flour. This material is combined with molding resins in the nature of a filler. It imparts strength to the molded part and because it is less costly per pound than the resins themselves, it contributes to their economy. Generally speaking it is a low priced commodity and the manufacturing costs are relatively high. To maintain a balance of economy in its production, sawdust and shavings are used as raw material.

Woodflour is made from hardwood as well as from softwood, and these two major classes are further divided into non-technical and technical grades. The manufacture of the latter requires extremely careful supervision, both as to gradings of the finished product and the choice of raw material. The woods in greatest demand for technical woodflour are white pine, spruce, and white birch, and complete freedom from bark is of prime importance. For the most part, woodflour in the past has been manufactured at a central point which is located near to sources of raw material. The outstanding drawback here is that raw material, coming from a dozen different points may differ to such an extent as to manifest itself in the finished product through variations of moisture, color, consistency, density and resin content. One class of application requires a granular product, whereas another may need one of fibrous quality. The exact finished product depends on the type of machinery used, which ranges from the stone grinder, the oldest type of equipment, down through the present day ball mills, roller mills, various types of hammer mills and attrition mills.

The separation of the various gradings requires an exact knowledge of modern screening methods as applied to light density products and also a comprehensive understanding of air separation methods. There are very few places where sufficient raw material originates to warrant a woodflour installation but where these do occur, there is a tendency to install small units. The greater capital expenditure involved is generally compensated for through a uniform final product and better satisfied customers.

Non-technical woodflour has less rigid specifications as to color, resin content and fineness, and its application naturally depends on the type of product manufactured which is generally outside of the phenolic resin plastic field. However, a cross-section of the specification for non-technical woodflour today shows more rigid requirements than applied to the technical grades ten years ago. As woodflour continues to find wider application as an inert filler, replacing in many instances, high-priced low density fillers, as well as cheaper heavy mineral fillers, there is a tendency for the specifications to approach the higher gradings.

Twenty years ago, more than half the woodflour used in this country was imported, but since that time, according to available statistics, the total consumption has grown from approximately 7,000 tons annually to 65,000 tons, which was reached in 1930. As the quality of the domestic product has improved to equal and in many instances, surpass that of the imported grade, woodflour has found wider applications and within the next decade, the total consumption in this country should reach 100,000 tons annually. This increased consumption has been brought about to a great extent through rapid growth of the phenolic resin industry and is also accountable to the research departments of our large industries, and to the willingness and cooperation of the railroads in establishing special freight rates from producing to consuming centers which have permitted the movement of woodflour over considerable distances.

*Composition Materials Co. Inc.

Asbestos in plastic compositions

BY A. B. CUMMINS*

THE term asbestos as employed in the plastics industry usually refers to the mineral chrysotile, a hydrous magnesium silicate of fibrous structure. Other varieties of asbestos such as amosite, crocidolite and amphibole may be employed for special purposes. The kinds of asbestos employed are "floats" or fine fibrous material, longer fiber grades and asbestos textiles in different stages of manufacture, all of which are employed to a very considerable extent for different purposes. Chrysotile asbestos contains ordinarily about 14 per cent of combined water which is not driven off appreciably at temperatures below 600 or 800 degrees Fahrenheit.

Asbestos is employed as a filler in plastic molding compositions particularly when high heat resistance, low water absorption and/or chemical inertness are required. When both high temperature resistance and maximum impact strength are required, long fiber asbestos is the only satisfactory filler. For heat resistant

*Johns-Manville Research Laboratories

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laminated compositions asbestos fabric is likewise the sole material that can be considered. The use of asbestos fabrics in the manufacture of brake linings, clutch facings and other friction materials is well known.

In molding compositions, asbestos is non-reactive, increases heat and fire resistance, improves chemical resistance, decreases water absorption, lowers shrinkage, decreases the coefficient of expansion. Long fiber asbestos increases mechanical strength and shock resistance, whereas "floats" tend to decrease the same. Asbestos increases the specific gravity over that obtained with organic fillers, but less so than some mineral fillers. Asbestos, unless it is first specially purified, is not satisfactory for the most highly electrically resistant compositions. However, large quantities are utilized in panels and other materials not having to meet the requirement of the utmost in electrical resistance. In molding compounds, asbestos "floats" give fair surface finish and satisfactory molding properties. Long fiber is not so satisfactory for appearance and has inferior flowing characteristics. It is also customary to find more difficulty in filling the molds with long fiber compounds. Likewise, in ashing, polishing, buffing and machining long fiber compositions, it is not possible to obtain perfect surfaces.

The types of resins used in making plastic compositions in which asbestos is used include most of those of commercial importance. Thus, asbestos is used to greater or less extent with the following: natural resins, shellac, rosin, sulphur, asphaltics, bituminous compositions generally, waxes, phenol aldehydes, alkyd resins, urea and thiourea aldehydes, polymerizable oils, rubber, chlorinated rubber, cellulose esters, flooring compositions, sheet protectors for metal surfaces, packings, friction materials, putties, furfural molding compounds, phenolic varnishes, etc. The listing on page 56 while not intended to be complete, shows the range of utility of asbestos in plastics, some of the types of products molded and a method of fabrication.

Other plastics, minor or proposed, employing asbestos for special uses are: polystyrene solutions, sulphonated phenol formaldehydes, orthocresol formaldehyde, furfural-phenol resins, chlorinated naphthalene compositions, olefin polysulphides, vinyl resins, hexamethyl tetramine compounds, cumarone resins, etc.

Asbestos fabrics, yarns, paper, etc. are satisfactorily coated or impregnated by well established trade procedures. In molding compositions, the fibers must be well coated for satisfactory results. With asbestos "floats" this is readily accomplished. With longer fiber, however, certain precautions are necessary. Long fiber compounds should not be rolled or ground. The following methods of processing asbestos-filled plastics are used:

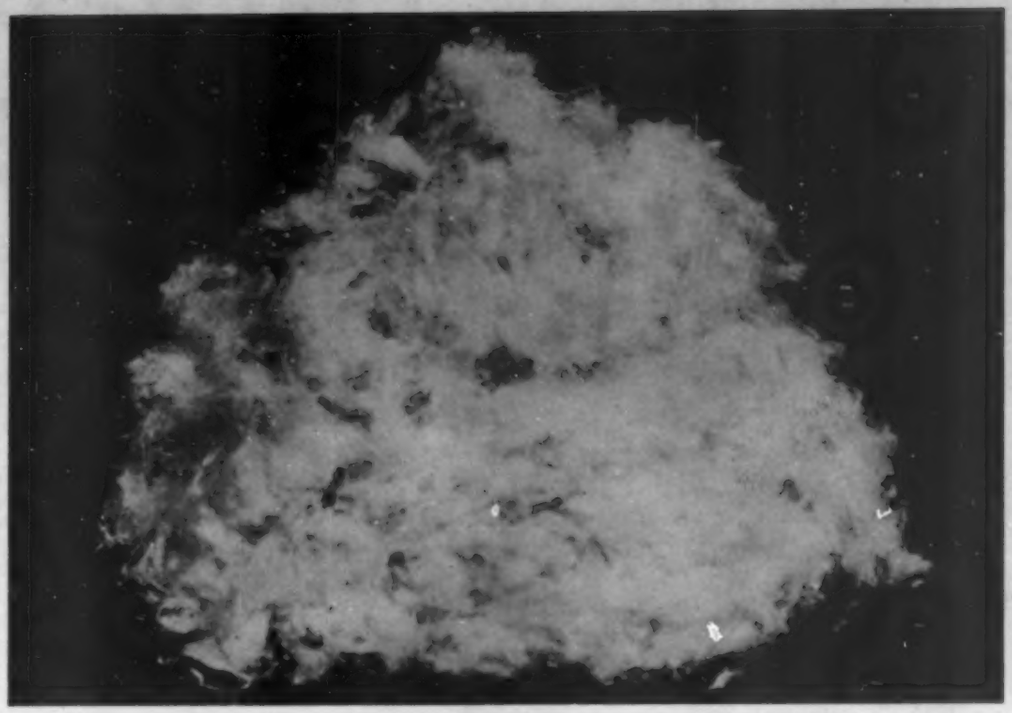
1. Impregnation of powders, floats, fibers, yarns, paper, fabrics, shreds, sheets, etc. with the binders in liquid form or in solution.

2. Incorporation of powder, floats, fibers or shreds with the binders in finely divided condition with or without a non-solvent liquid medium.

3. Incorporation of powder or floats or shreds in suitable mills, after the materials have been mixed at ordinary temperature or at the temperature required for the binding medium employed. Method "One" is preferred for long fiber; Method "Three" should never be employed for fiber longer than "floats."

JOHNS-MANVILLE

Asbestos ore as it comes from the mines before it is broken and crushed into fillers



Asbestos fiber is obtained by breaking asbestos ore from the rock, then crushing it. The resulting fiber is excellent insulating material and is entirely fireproof

Grades of asbestos for plastic molding

Asbestos is graded at the mines by the "Quebec Standard Testing Machine" by which the grades are designated on the basis of the ounces from an original one pound sample that are retained on standard screens of 2, 4 and 10 mesh openings per inch. On this basis, the so-called long fiber asbestos employed in plastics corresponds in general to the following:

Quebec Classification	*Quebec Screen Test*
4 M	0, 4, 8, 4
4 Z	0, 1½, 9½, 5
5 R	0, 0, 10, 6
6 D	0, 0, 7, 9

Where the Quebec screen test is not sufficiently complete, dry screen tests with other screens are made with the Rotap or equivalent apparatus.

Thus, for 5 R and 6 D fibers the following Rotap analyses have been obtained:

	5 R	*6 D*
On 10 mesh	30%	11%
On 35 mesh	42%	48%
On 150 mesh	8%	15%
Through 150 mesh	20%	26%

For asbestos floats, specifications vary considerably, depending on the use and the cost permissible. Asbestos floats (7 R Grade) have a Quebec test of 0, 0, 0, 16. Examples of customers' specifications are as follows:

Customer A.

	Per cent
On 20 mesh	5
On 48 mesh	42
On 65 mesh	20
On 150 mesh	12
Through 150 mesh	21

Customer B.

Moisture	2.0% maximum
Grit and metallic Particles	0.2% maximum
Oil Absorption	4.0% cc./5 gm. maximum
Through 200 mesh	35-50%
On screens coarser than 40 mesh	30% maximum
On screens 50-200 mesh	25% minimum
	Maximum not generally specified.

Customer C.

No long fiber or unmilled fiber particles.

On 20 mesh	2.0% maximum
Grit (by flotation)	0.3% maximum

Customer D.

On 14 mesh	Trace only
On 20 mesh	5% maximum
Minus 20 mesh	93-95%
Grit, etc.	3-4%
Oil Absorption	Max. 5 cc. oil/10 gm. floats.

JACK OF ALL TRADES AND MASTER OF EACH

DUREZ resins have countless uses in . . .

AUTOMOTIVE, COMMUNICATION, BUILDING, ELECTRICAL, PAINT

AND MANY OTHER FIELDS

WHAT ARE THESE RESINS?

They're synthetic or artificial gums built up from chemicals. Durez resins are phenol-formaldehyde derivatives which set infusibly by chemical reaction —not mere oxidation. They are used for such diverse purposes as bonding metal to wood or rubber; impregnating pulp, fabrics, asbestos; protective coatings for wire, metal, rubber, wood, composition; for insulating, sizing, bonding, acid and waterproofing.

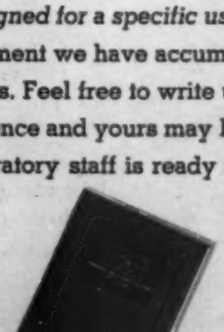
WHAT DO THEY DO?

The jobs that a Durez resin can do are almost unlimited. Used to impregnate brake linings they lengthen life, end squeaks. They waterproof paper and cardboard containers. They are used to impregnate noiseless, long-wearing fabric gears. To plywoods they impart resistance to moisture, vermin and fungus growth. Applied to a variety of materials, they add

RESISTANCE TO

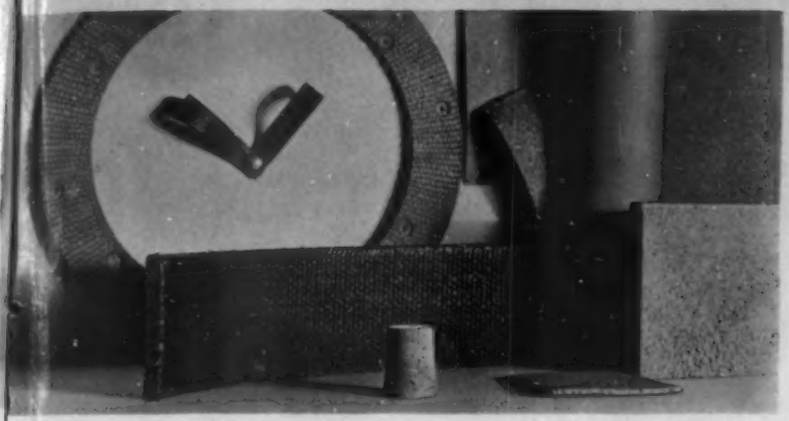
SOLVENTS	FRICTIONAL WEAR
OIL	HEAT
GREASE	ACIDS
CAUSTICS	ELECTRICITY

There are over 100 Durez resins, each designed for a specific use. In our many years of research and experiment we have accumulated data on a wide variety of applications. Feel free to write us in complete confidence so that our experience and yours may be combined to mutual advantage. Our laboratory staff is ready to cooperate on specific applications involving synthetic phenolic resins. In writing, give as much information as possible. Address General Plastics, Inc., 710 E. Walck Road, North Tonawanda, N. Y.

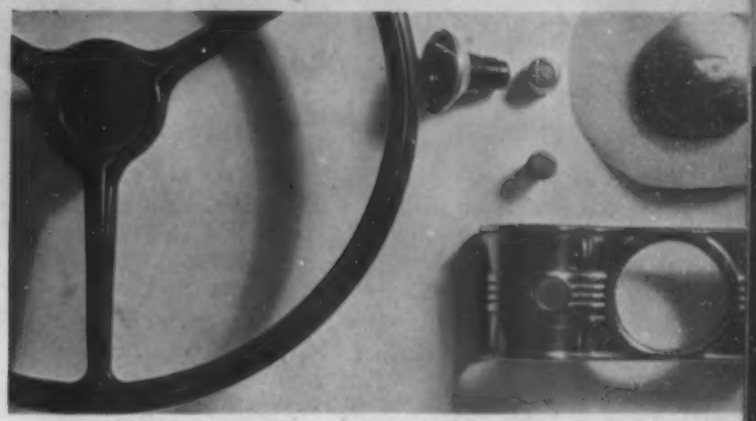


SEND FOR FREE BOOKLET

How Durez resins are being used to produce a better product



FOR IMPREGNATING... Durez resins impregnate paper and fabrics, make sheet laminated material that is dielectric and resistant to water, solvents, mild acids and alkalis. They reduce the porosity of metal castings. They impregnate flexible woven belting, make it strong and long-wearing. Brake linings show longer wear and a more uniform friction coefficient when impregnated with Durez resins. Silent gears and bearings, that never need oiling, are made with Durez resins. They impregnate wood, make it stronger, give it a smoother finish.



FOR COATINGS THAT MUST WITHSTAND SEVERE SERVICE... Durez resins coat hard rubber steering wheels, give them resistance to abrasion and perspiration. They are used in the rayon industry to coat metal parts in contact with chemicals, and prevent corrosion. They coat paper textile tubes, prevent bleeding, and enable them to withstand the action of water, dyes, bleaches and chemicals. They make excellent coatings for porous materials, such as paper, composition board and concrete. The hard, flexible coatings will last indefinitely.

FOR BONDING... Durez resins bond plywood, veneers, high speed grinding wheels, giving them strength, resistance to frictional wear and heat. They bond graphite to form long-wearing commutator brushes that will not soften under heat. They are used for fixed resistance units, the resins acting both as a bond for the inert filler and supplying the necessary electrical resistance. They bond sand cores, make possible the production of smoother, less porous metal castings.

AS ADHESIVES... Special Durez resins have been developed for binding bristles in brush backs and steel paint brush ferrules. They cement molded plastics or composition together... fasten glass bulbs to composition or metal sockets. They bond rubber and wood to metal. They make flexible abrasive cloths and waterproof sandpaper. Durez resins produce a strong, permanent bond that is resistant to oil, solvents, soaps, mild acids and alkalis.

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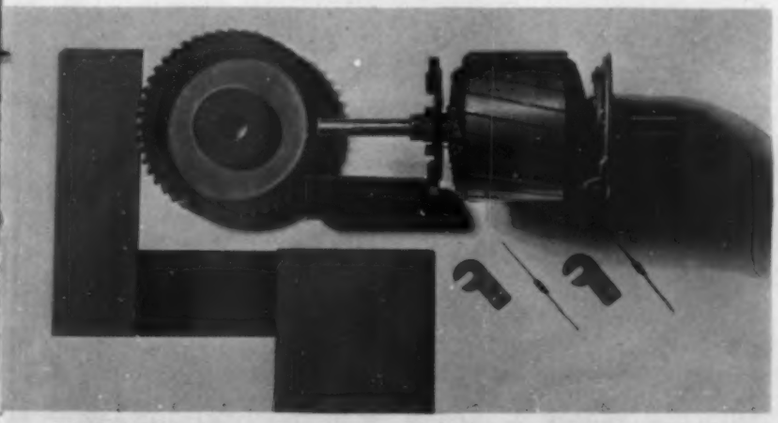

FOR INSULATING... Durez resins impregnate the armatures of electric motors that must withstand severe service. Here they provide high insulation, strong mechanical bonding and resistance to water, oils, heat and chemicals. Durez resins coat wires, coils, and numerous other electrical parts that must have high insulation value.

Durez resins are one of the most versatile of man-made products, with thousands of industrial applications. Have you any uses—present or potential—for these resins in your plant? Why not find out?... Write us today.

★

DUREZ

POWDERED – SOLUTION – COLLOIDAL

Resins

SEE DUREZ ADVERTISEMENT ON PAGES — 302-303

(*Continued from page 53*) **Some uses of Asbestos in plastics compositions**

Type of Resin	*Use*	*Method of Fabrication*
Rosin, with or without waxes, gilsonite, creosote, shellac, mineral oils, phenolic resins, etc.	Electrical insulations Box toe compositions Roofing compositions Laminated boards	Hot molding—chilling " " " " pressing— " " " "
Shellac, with rosin, creosote, lime, etc.	Electrical insulations and miscellaneous uses	Hot molding—with or without chilling
Asphalts, tars and pitches, with chlorinated rubber, oils, solvents, etc.	Heat insulator coatings for metal pipes. Parts for electrical and heat appliances	Brushing Drying, cold molding, using waterproofing molding
Waxes (Montan, carnauba, etc.) with shellac, nat. resins, gilsonite, modified rosins, mineral oils, etc.	Casting, coating, molding Box toe compositions Roofings	Hot molding—chilling " " " " pressing— "
Polymerizable oils	Joints, coating compositions, etc.	Brushing, trowelling, etc.—curing
Rubber or chlorinated rubber, with or without alkyd resins, etc. with or without organic filler and asbestos	Brake linings, clutch facings, valve discs, gaskets, packings, etc.	Hot molding, curing
Phenolics, alone or with nat. resins, rubber, inorganic filler (silica or mica) and asbestos, floats, long fiber, paper, yarn or fabric	Laminated boards Friction materials, automotive applications, etc. "Haveg" type compositions Coating compositions, books, papers, etc. Molded heat resistant compositions Impregnated sheets, panels, or boards, gaskets, valve discs, etc. Asbestos fabric pressed as blocks Asbestos sheet as spacers for heat insulators Asbestos yarns, etc. for clutch facings, etc.	Hot pressing " molding Hot molding Curing Hot molding Laminated under heat and pressure Heat and pressure Hot pressing Hot molding
Cellulose esters	Asbestos and cellulose esters used to increase strength and toughness of glycerol phtholate molding compounds	
Alkyd resins	Commutator rings Mica sheets Brake linings Door stripes, electrical spools, etc. Structural tiles Wood veneer panels Acid proof coatings	Hot molding—chilling—curing Hot molding—chilling Cold molding—curing
Phenolic varnishes	To increase adherence to coated surface, to increase flexibility of undercoatings, on metal surfaces, also used in packings, putties and boards	Varies depending on application
Sheet protection for metal surfaces	Asbestos paper or sheet is connected to metal surface by phenolic resin and then coated with the same material	Curing by heat and pressure

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CELLULOSE ACETATE

CHEMICAL COTTON

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PLASTICIZERS

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Diatomaceous silica in plastics

BY A. B. CUMMINS*

DIATOMACEOUS silicia has been used as a filler in certain plastics compositions for a considerable period; however, its broader applications have come about within the past five years, principally because of the availability of suitable and standardized grades, the accumulation of reliable data on the advantages of using the same, and the distribution of knowledge in the manipulation of compositions containing diatomaceous fillers.

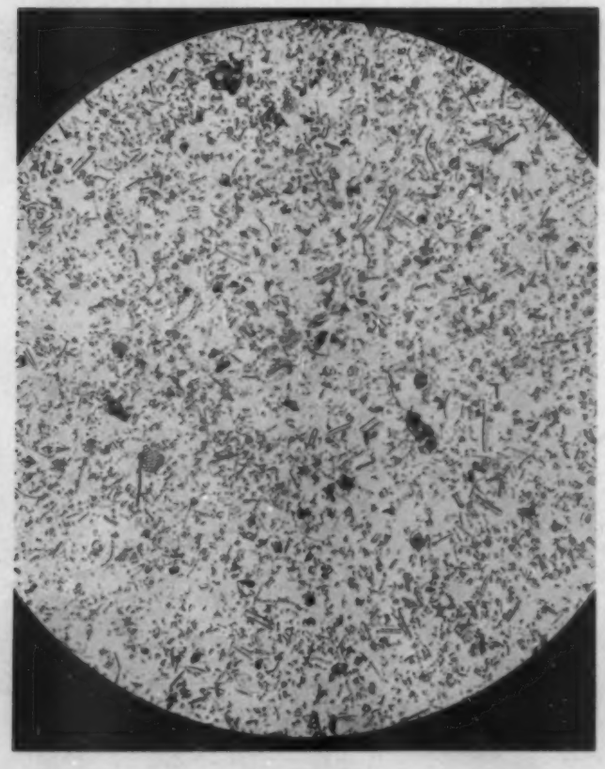
Diatomaceous silica is essentially an amorphous silica of organic origin, being the fossil remains of microscopic plants known as diatoms. As provided for the plastics industry, the material is an impalpable powder of extreme lightness, high absorptive capacity, chemically inert and heat stable at all temperatures up to 2200° F. or more. Celite is the trade name given to specially prepared diatomaceous silica from extensive marine deposits of the Miocene period near Lompoc, California. It is of high chemical purity and the most desirable physical and microscopic structure. The care with which the different grades are processed provides a uniformity of product that is greater, perhaps, than for any other inorganic filler used in the plastics industry.

It is available in several grades (natural, calcined and chemically processed) of different particle size distribution and fineness. All are of high silica content (90-94% SiO_2). The true specific gravity ranges from 2.0 to 2.3, which is the lowest of any common inorganic filler. It mixes and bonds well with nearly all resins, both natural and synthetic. Molding powders made therefrom are of excellent and uniform surface finish and fine gloss. Rolling, molding, milling and ejection properties are good.

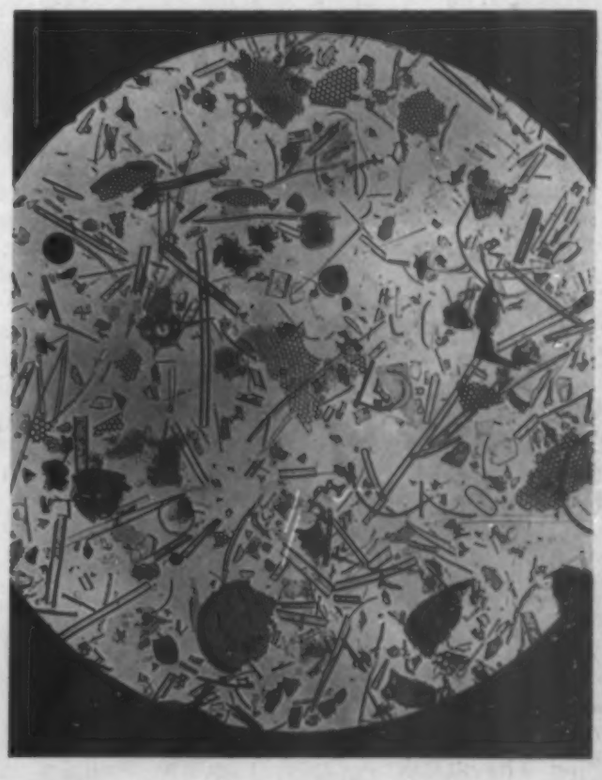
The properties of plastic compositions employing this filler in general are: low molded specific gravity (for mineral-filled products), increased hardness, usually increased flexural, compressive and tensile strengths, exceptionally low water absorption, excellent electrical properties (dielectric, power factor and resistance to arcing), increased heat and chemical re-

* Johns-Manville Research Laboratories

PHOTOMICROGRAPHS BY JOHNS-MANVILLE



Photomicrograph showing fine particle size of diatomaceous filler. Magnification 380 times



Coarse particle size of the same filler shown by photomicrograph. Magnification 380 times

Comparison of Properties of Phenol Formaldehyde Molding Compounds Containing as the Filler Celite 110, Asbestos Floats, Wood Flour and Combinations Thereof.

Property	*Celite 110 50%*	*Asbestos Floats 50%*	*Wood Flour 50%*	*Celite 110 25% Asbestos Floats 25%*	*Celite 110 25% Wood Flour 25%*
Specific gravity, molded	1.62	1.73	1.35	1.67	1.49
Hardness, Brinell, Load 500 Kilos.	55–57	44–46	34–40	50–51	48–49
Flexural strength. Modulus of Rupture, lbs./sq. in.	8500 to 12,000	5000 to 8000	8500 to 11,000	8000 to 10,000	7000 to 9000
Compressive strength, lbs./sq. in.	20,000 to 24,000	15,000 to 20,000	20,000 to 24,000	21,000 to 23,000	24,000 to 26,000
Tensile strength, lbs./sq. in.	4900 to 6400	3800 to 4000	4800 to 5300	4400 to 5900	4400 to 5600
Impact strength, ft. lbs./in. sq.	1.4–1.7	1.3–1.6	1.9–2.2	1.5–2.0	1.4–1.75
Water absorption, 48 hr. immersion, room temp.	0.04–0.05%	0.06–0.24	0.50–0.90	0.06–0.07	0.5–0.6
Water absorption, 30 min. Boiling water	0.04–0.05%	0.12–0.20	0.40–0.50	0.05–0.09	0.30–0.38
Dielectric strength. Step (volts/mil)	280–370	280–315	240–350	280–315	260–290
Power Factor. Audio frequency, 1000 cycles	3–5	13–15	3–10	8–10	5–6
Power Factor. Radio frequency, 1,000,000 cycles	1.5–1.6	.....	3.5–4.5	.....	.....
Resistance to arcing. (Times to produce continuous path)	9–12	4–6	7–8	.....	.....
Resistivity, megohm/Cms.	19–20 x 10^5	.....	1–5 x 10^5	.....	.....

sistance. Among older and established uses of diatomaceous silica in the plastics industry are the following: battery boxes and molded asphaltic compositions (20,000 tons or more of filler per annum), sulphur compositions, phonograph records (shellac, Vinylite, etc.), porous battery separators, resin-bonded abrasive compositions, rubber products.

Some newer, important applications are: molded commutators, heater plug connectors, box toe compositions, many types of molded electrical parts, molded friction elements, in wood flour-filled phenolic compositions in small percentages for improvement in surface appearance and molding properties, in larger proportions (up to 60%), either alone or in combination with wood flour or asbestos for molded parts of high heat resistance, low water absorption or superior electrical properties. It appears that the application of diatomaceous silica generally in plastic compositions is still greatly undeveloped, and it is believed that the unique properties of diatomaceous fillers merit their careful investigation for all uses of the different plastics in which the properties listed above are desired. Up to the present, the greatest applications have been with the asphaltics, phenol-aldehydes, cellulose plastics, alkyd resins, casein plastics, chlorinated rubber and others of the new synthetic resins.

Some grades of the filler are especially suitable for the lighter colors in molded phenolics and other darker colored resins; with the translucent plastics, it is admirably suited. Other grades have been successful in providing molded parts for use as super-insulators and for closures, etc. of surprisingly low water absorption. The material has a slight tendency to lower the impact resistance in some molding compositions. It likewise increases slightly machining difficulties as compared with organic fillers, but is less objectionable in this respect than other inorganic fillers. The first disadvantage is overcome, when necessary, by combination with fibrous fillers; the latter by the use of harder and superior cutting tools. In the processing and molding of plastics using this filler, there is encountered occasionally some necessity for slight modification of technique and operation. By study of actual working conditions, procedures have been developed which have overcome all difficulties to date.

Specifications for diatomaceous silica fillers may be safely covered by purchasing by trade-name. Thus, [1]Grades 110, 521, SS, FC, Super Floss, etc. represent small but important differences in particle size and suitability for specific purposes. Satisfactory general specifications for these products are:

	110	*Super Floss*	*521*	*SS*	*FC*
Moisture, per cent	0.5	0.5	0.5	0.5	4.0
Per cent on 30 mesh	None	None	None	None	None
Per cent on 150 mesh	1.0	None	3.0	7.0	7.0
Grit, scale and foreign impurities	None	None	None	Trace	Trace
Color	White	White	Pink	Pink	Gray
Silica Content, per cent	90	93	92	91	90 (dry basis)
Specific Gravity	2.3	2.3	2.15	2.15	2.2
Apparent Density, lbs./cu.ft.	10	8	8	9	9
Reactive Iron	Minimum	Minimum	None	Very low	Low
Soluble Constituents	Very low	Very low	Extremely low	Low	About 0.2%

The tabulation above for phenol-formaldehyde molded compounds will be useful in comparing the properties of compositions employing this filler with those containing asbestos and organic filler.

[1] Refers to Celite

Purified wood cellulose filler

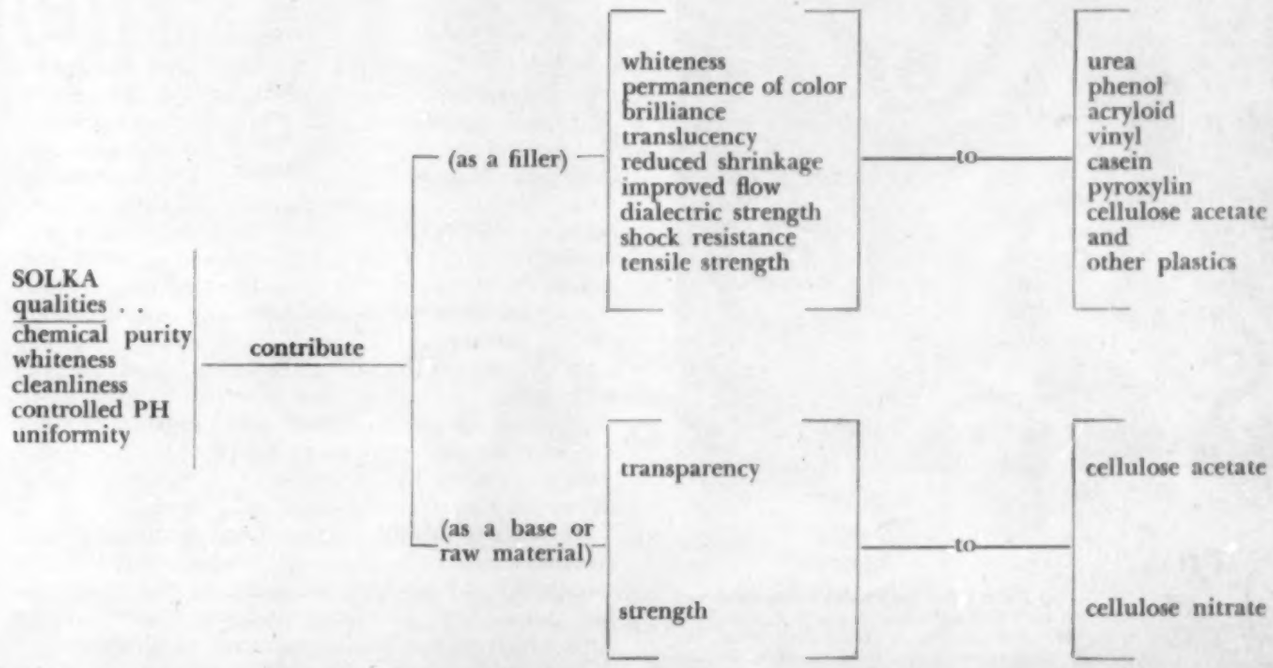
BY R. K. ESKEW*

THERE is perhaps no other industry which in the last ten years has developed as rapidly or which has entailed the changes and improvements in technique as that of the manufacture of molded plastics. Scarcely a week passes that patent or trade publications do not reveal some new plastic with alleged improvement in cost of manufacture, beauty or physical properties. Many of these never reach commercial importance, but those which have established their merits are finding a continually widening field of application.

The beauty and versatility of the finished product from these resins is in no small part the result of employing the proper filler. In many cases, particularly with light colored products, the results were achieved through the use of Solka,[1] a highly purified wood cellulose which is available in a number of physical forms, several of which find use as fillers in molded compositions. More than one well known manufacturer of urea formaldehyde resins, whose products have achieved the highest reputation in their field,

* Technical Service, Brown Company

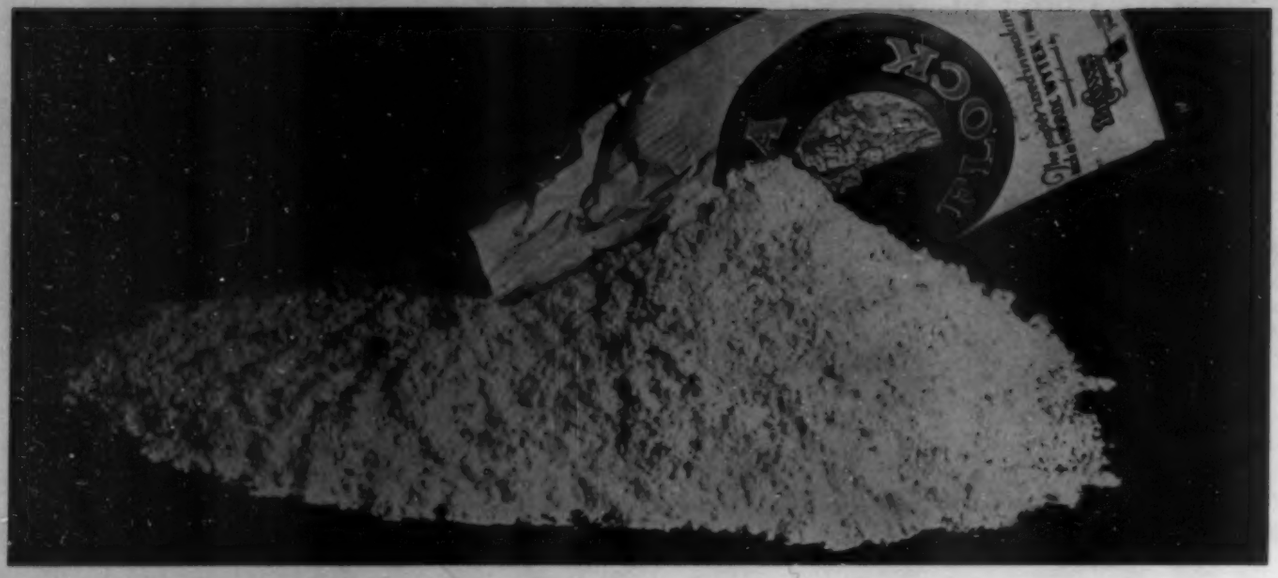
[1] Registered trade-mark

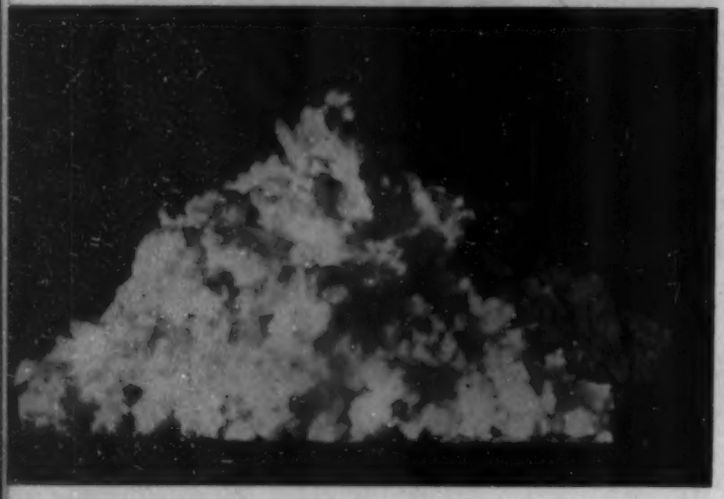


PHOTOS, COURTESY BROWN CO.

1. Flat sheets, which may be later shredded and ground or impregnated

2. Flock or flour, all ready for mixing



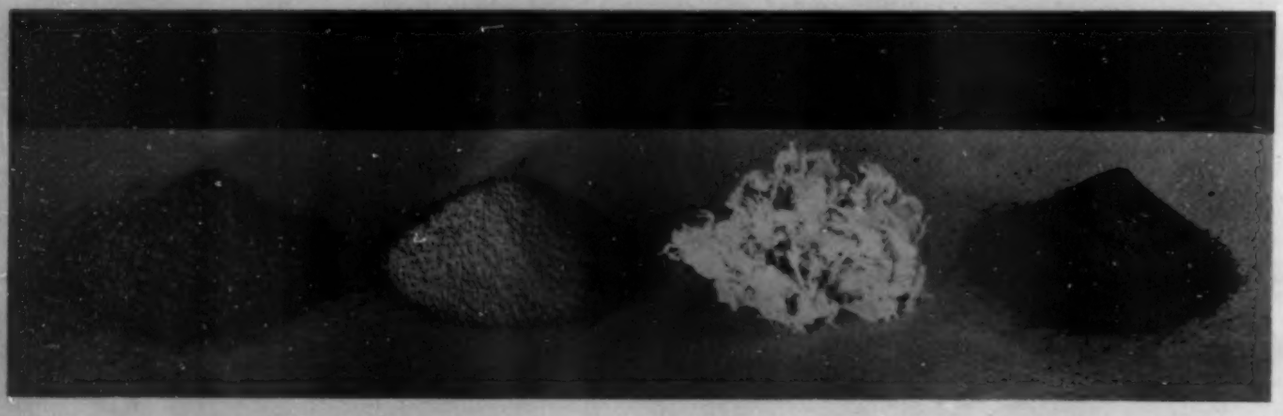


3. Top photo shows flock which comes packaged free from dirt and ready to use as a filler. Next photo, fluffed Solka, a fibrous form closely resembling cotton linters in appearance. Below—Flock before and after combining in molding compounds

maintains the uniformity and delicacy of color in his pastel shades through the use of this filler. For incorporation with urea formaldehyde resins, it is generally purchased in the form of a pulp dryer sheet, which sheet is disintegrated by the resin manufacturer and impregnated with the liquid resin, the mass being later dried and ground with the coloring matter. Some molders prefer to buy the material already pulverized, in which form it is designated as Flock and can be incorporated with the pulverized resins. Flock is available in two degrees of whiteness and in various meshes. In the manufacture of laminated plastics, extensively used for the fabrication of decorative wall panels, the filler is usually first made into a sheet of paper which imparts to the finished product the desirable characteristics possessed by the base pulp. There again the cleanliness, strength and uniformity of the fibre are of paramount importance.

Not only is this filler adapted to use with the light colored resins such as the urea, vinyl, and acrylate groups, but it finds application also in phenolics, rubber and dark resins where special properties are desired which cannot be obtained with woodflour.

The outstanding characteristics of purified wood cellulose which adapt it to use as a resin filler are its whiteness, uniformity in color and physical state, permanence, cleanliness, and controlled pH. The



Old MR. BOSTON *chooses* INDUR

*for its handy measuring cup caps**

Ben Burk, Inc., distillers of the Old Mr. Boston Gins and other distinctly American liquors, had a clever idea for completing the smart appearance of their gin bottles . . . molded caps designed to provide users with a jigger measuring cup.

They had still another good idea when they chose Indur as the material. Indur has the toughness, the resiliency and the high-class appearance to make such a device appealing to the eye and handy to the hand.

Indur meets all fabricating specifications and filling line requirements. And the cost is right down the purchasing agent's alley. Perhaps you have a product that needs the finishing touch which Indur always gives. We shall be glad to make suggestions . . . without obligation, of course.

* MOLDED BY TERKELSEN ON TERKELSEN PRESSES

Reilly Tar & Chemical Corp.

FIFTH AVENUE AT 42nd ST., NEW YORK, N. Y.

properties which it contributes to the molded product are high shock strength, high dielectric strength, high heat resistance, high tensile strength, high color and chemical inertness.

When the light colored urea resins were first being developed commercially cotton flock was used as a filler but it was later found that the delicate pastel shades, surface luster and brilliance of color, which might be expected from the resin itself, could not be easily obtained with cotton flock.

Although made from wood, Solka should in no way be confused with wood flour. The latter is pulverized wood which contains approximately 50 per cent, resinous and other non-cellulosic material whereas this is the purified cellulose first isolated from the tree and then made into sheets or pulverized. It is free from dirt, resins and other materials unsuited to a molded composition. Wood flour has its place in molded plastics which do not require a standard sufficiently high to justify the use of this type of filler. However, the purified cellulose filler is being used to an increasing degree in dark phenolic resins to obtain certain special properties such as improved dielectric strength, shock resistance, improved flow during molding, superior surface appearance, and reduced shrinkage and distortion.

It is interesting to note that this material enters the field of plastics other than in the capacity of a filler. To a rapidly increasing degree it is replacing cotton as the basic cellulose material for the manufacture of cellulose acetate and cellulose nitrate plastics. The high standards of clarity and permanence necessary for the production of transparent products from these plastics demand a cellulose of the highest purity and cleanliness. It meets these demands as well as those of a high quality filler and may thus be considered to have contributed in two ways to the advancement of the organic plastics industry.

Cotton flocks

BY F. STEINFIELD*

SINCE filler is an important component part of nearly all plastic compositions, the choice of a material with the right filler is of equal import. This choice depends primarily upon the use intended for the material specified and a fundamental understanding, at least, of the fillers available will contribute to an intelligent choice.

Woodflour, asbestos, diatomaceous earth, and purified cellulose are outlined in adjoining articles, each with its advantages and limitations. A brief study of these little stories will give a clear picture of the necessity and advantages of fillers in general and a basis upon which to specify plastic materials with a definite end of satisfactory service in view.

Cotton flocks and canvas are also extensively used when greater strength in the finished part is required. Canvas particularly, is used in laminating where the resulting material has sufficient strength for light or heavy gears, miners' helmets, and similar applications. It is also used in molding compounds where the part produced depends upon strength rather than appearance for its successful use.

Shredded canvas or other fabric in a molded part, while giving greater impact resistance and tensile strength, makes finishing difficult. The tiny shreds are visible in the flash and are hard to remove even where fins are ground off in finishing. In most applications where canvas is used, however, this circumstance does not constitute a major objection. Edges may be finished with reasonable satisfaction and the additional strength contributed to the part by canvas outweighs this minor disadvantage.

In molded parts, however, where greater strength and fine finish are both required, they are obtained through the use of cotton flocks which may be worked into resinous material by the material supplier when the resin is compounded. Lighter colored flocks are used in the manufacture of molding materials where high mechanical strength is required as well as light color. Where woodflour is used, it is necessary to add a considerable quantity of white pigment to the compound if a light color is desired and this reduces the mechanical strength of the material produced. The higher strength given to the material through cotton flocks is particularly important in such applications as bottle caps or other parts subjected to much handling and use.

All flocks (they are available in a variety of lengths) may be used to increase mechanical strength of regular compounds. They give to such compounds a happy medium of strength between those filled with woodflour and fabric-filled materials. Flocks with longer fibre length give compounds nearly as strong as some of the fabric-filled materials, yet the molded parts made from them are as easily finished and good-looking as those in which other fillers of less strength are used. Fabric-filled materials are all inclined to show particles of the cloth in the surface of the finished molded part and cannot, therefore, be used where a good-looking molding of uniform color is desired.

Due to the length of the fibre, coverage of the flocks with the resin and dye is somewhat more difficult than with woodflour but can be accomplished by using soft resin. By the term "soft resin" we mean one which becomes quite fluid while being compounded under heat. It is difficult to give any formulation for the use of cotton flocks as a filler since the quality of the product mechanically and in appearance depends to a large extent on the resin used, the type of equipment and the method of compounding and the final grinding of the compound. In general, however, it may be said that the direct substitution of cotton flocks in standard formulations for woodflour will give molded parts with higher mechanical strength although mechanical tests of molded bars with each type of filler show little difference.

* Claremont Waste Mfg. Co.

The coloring of plastics

W. H. PEACOCK* and R. H. KIENLE*

IN THE use of plastics, color is one of the principal requirements. The coloring of plastics, therefore, becomes one of the major problems of the plastic manufacturer. In spite of its importance, literature on the coloring of plastics is none too voluminous. Much of it relates to problems and effects in particular types of materials. It is the purpose of the present article to consider the coloring of plastics in entirety rather than from the viewpoint of any specific material or plastic application. First because the field is extensive, binders, fillers, and colors will be classified; then general applications will be discussed, so called "trouble shooting" will be briefly reviewed, and finally some consideration will be paid to the production of special effects.

A study of the coloring of plastics readily discloses that it involves the dyeing of more chemically diverse materials than is found in any other field. These numerous materials are classified in Table I and II. It is evident that no one group of dyes will be suitable for all these products.

TABLE I

Fillers Commonly Used in Plastic

Inorganic
- Asbestos
- Mica
- Silicas
  - Flint, quartz, sand
- Silicates
  - Clays
  - Infusorial earths
  - Kieselguhr, Bentonite, etc.
  - Slags
- Aluminium hydrate
- Alkaline earth salts
- Magnesium oxide, carbonate, etc.
- Lime
- Calcium carbonate
- Barytes

Organic
- Wood flour or fiber
- Cotton linters or flock
- Alpha Cellulose
- Seed hulls
- Vegetable fibers
- Plasticizers
  - High boiling
  - Alcohols, ketones
  - Esters, ethers, etc.

TABLE II

Binders Commonly Used in Plastics

I. *Non-Convertible (Thermoplastic)*
- a. Natural
  - 1. Organo-soluble
    - Rosin
    - Copals
    - Shellac
    - Rubber
  - 2. Water soluble
    - Glue
    - Gelatine
  - 3. Emulsions
    - Rubber latex
    - Waxes
    - Resins
  - Petroleum products
    - Asphalt & bitumens
    - Paraffins
  - Drying oils
  - Waxes
    - Albumines
    - Gums
- b. Artificial or Synthetic
  - 1. Ethylene addition polymers
    - Vinyl halides
    - Vinyl esters
      - Copolymerized with halide
      - Modified with aldehyde
    - Vinyl ether
    - Acryl type
      - Acrylate esters
      - Acrolein
      - Acrylonitrile
    - Aromatic Vinyl
      - Styrenes
      - Cumar, Indenes
    - Ketenes
    - Methylene ketones
    - Divinyls
  - 2. Condensation Polymers
    - Polyesters
    - Cellulose esters
    - Cellulose ethers
    - Phenol—Aldehyde (Acid catalyzed)
    - Dihalogenated hydrocarbons and metallic sulphides
  - 3. Miscellaneous
    - Aromatic halides
      - Chlorinated naphthalenes
      - Chlorinated diphenyls
    - Emulsions
      - Lacquers
      - Resins

II. *Convertible (Thermosetting)*
- a. Natural
  - 1. Protein—Aldehyde
    - Casein
    - Gelatine
    - Albumin
  - 2. Shellac
    - With suitable catalysts
  - 3. Aromatic gums
    - Gum accroides
    - Urishol
- b. Artificial or Synthetic
  - 1. Addition Polymers
    - Polyvinyls
  - 2. Condensation Polymers
    - Aldehyde type
      - Phenolic
      - Aromatic amines
      - Aliphatic amines
        - Urea, thiourea
      - Ketones
      - Sulfonamides
    - Polyesters (alkyds)
  - 3. Hybrid Polymers
    - Unsaturated polyesters

* The Calco Chemical Company, Inc.

Drying oils
Oxidizing alkyds

To the colorist it is helpful to classify all the various materials to be dyed into some practical grouping, however broad. These materials can be placed into one of four familiar groups, namely:

1—Matter of Animal Origin—Protein Products—Often Amphoteric
2—Matter of Vegetable Origin—Cellulosic Products
3—Matter of Mineral Origin—Inorganic Materials
4—Synthetic or Artificial Products

The synthetic or artificial products are difficult to classify. Such products as synthetic resins, cellulose esters, plasticizers, varnishes, paints, cosmetics, and prepared food products such as gelatin desserts are typical of the all-inclusive nature of this group.

The chief aid of these groupings to the colorist is that it assists in the classifying of coloring matter according to affinities. With dyestuffs, a knowledge of the application properties is usually more helpful than a knowledge of chemical constitution. Coloring materials for plastics can be broadly divided into seven groups, namely:

1—Dyes for Proteins
2—Dyes for Cellulose
3—Lakes, Toners and Insoluble Dyes
4—Mineral Pigments
5—Spirit Soluble Colors
6—Oil Soluble Colors
7—Special Coloring Matters

"Protein" and "Cellulose" dyes can be further subdivided, according to their specific application properties, into: Acid, Mordant, Basic, Direct, Developed, Acetate, Sulphur and Vat. The properties of the dyes in these subdivisions is well known particularly in so far as their use in the textile field is concerned. As there are numerous texts covering that field they will not be discussed further other than to include in Table III some of their general properties of interest to plastic colorists.

The group of special coloring matters includes those dyes and mixed coloring matters especially developed for the plastic field. Several dyestuff manufacturers have carried out extensive researches to study and develop special lines of dyes, and such lines are suitable for particular types of plastics. The use of such dyes is recommended, in all frankness, as they have been prepared with a knowledge of the requirements and conditions of actual trade practice. Each dyestuff manufacturer groups such dyes under a special trade name, such as "Condensation Dyes," "Phenoform Dyes" or "Resin Dyes."

For the successful solution of the color problems facing the plastic manufacturer, close cooperation between the research and production men of the plastics and dyestuff industries is required. Such cooperation has already proven of immense value. Thus it has served to disclose the effect of the coloring matter on plasticity, dielectric properties, and cure. It has emphasized the importance of ease and uniformity of dispersion, solubility, covering power, tinctorial strength, light and chemical stability of colors. It has brought out the difficulty of controlling hue from batch to batch due to changes in the self shade of the binders and other ingredients used, as well as variation induced in these ingredients during the molding and curing cycles. It has emphasized that continual control runs in the plastics laboratory should be made. It has shown the importance of the materials used in mold construction and of the necessity to standardize molding conditions. It has brought home to both color and plastic manufacturers the economic problems facing each industry.

Even the most suitable coloring matter, if not prop-

TABLE III

General Properties of Coloring Matter used in Plastics

				Solubility				*Fastness Properties*				
Group	*Type*	*Affinity*	*Hue*	*Water*	*Alcohols*	*Hydro-Carbons*	*Dispersibility in Resins*	*Heat*	*Aldehydes*	*Light*	*Alcohol & Water*	*Uses*
1	Acid Dyes	Direct for Proteins	Bright & strong	Good	Spar.	Insol.	Generally poor, varies with dye and conditions	Mod.	Varies	Good	Bleeds	Protein plastics, cast phenolic, urea resins and water sol. binders
1	Mordant Dyes	Direct for Proteins	Somewhat dull	Good	Spar.	Insol.	Generally poor	Mod.	Varies	Very good	Bleeds	Same as acid dyes
1	Basic Dyes	Proteins, certain clays high Tannin Cellulosic materials	Very bright & strong	Good	Good	Insol.	React with many resins Good	Mod. some reds are good	Varies	Poor	Bleeds	Can be applied to most plastics
2	Direct & Developed Dyes	Cellulosic materials	Somewhat dull	Good	Spar.	Insol.	Generally poor	Mod.	Varies	Mod.	Bleeds	Used to color cellulosic fillers
2	Sulphur Dyes	Cellulosic materials	Dull	Sol. in Na_2S solutions	Insol.	Insol.	Poor	Mod.	Good	Good	Good	Used chiefly for rubber tire fabrics and trubenized cloth
2	Vat Dyes	Cellulosic materials	Somewhat dull & weak	Sol. in alkaline reducing solution	Insol.	Insol.	Moderate	Mod.	Varies	Good	Good	Useful in many plastics but they are expensive
2	Acetate Dyes	Cellulosic acetates	Bright	Insol.	Spar.	Varies	Moderate	Good	Varies	Mod.	Bleeds	Resins and cellulose esters
3	Colors and Lakes	All materials by adhesion	Bright	Insol.	Insol.	Insol.	Good	Good	Varies	Mod.	Bleeds	Resins and cellulose esters
4	Pigments	All materials by adhesion	Soft toned, dull	Insol.	Insol.	Insol.	Good	Mod.	Varies	Mod.	Bleeds	Cellulose acetate fabrics
5	Spirit Soluble Colors	All materials by absorption or adhesion	Bright & strong	Many are sol.	Sol.	Spar.	Good	Varies	Varies	Good	Bleeds	Most plastics
6	Oil soluble colors	All materials by absorption or adhesion	Bright & strong	Insol.	Spar.	Good	Good	Good	Good	Good	Good	All opaque plastics

erly applied, may give unsatisfactory results, as none can be made absolutely fool-proof. The good results being obtained today are due to constant care and correct methods of application.

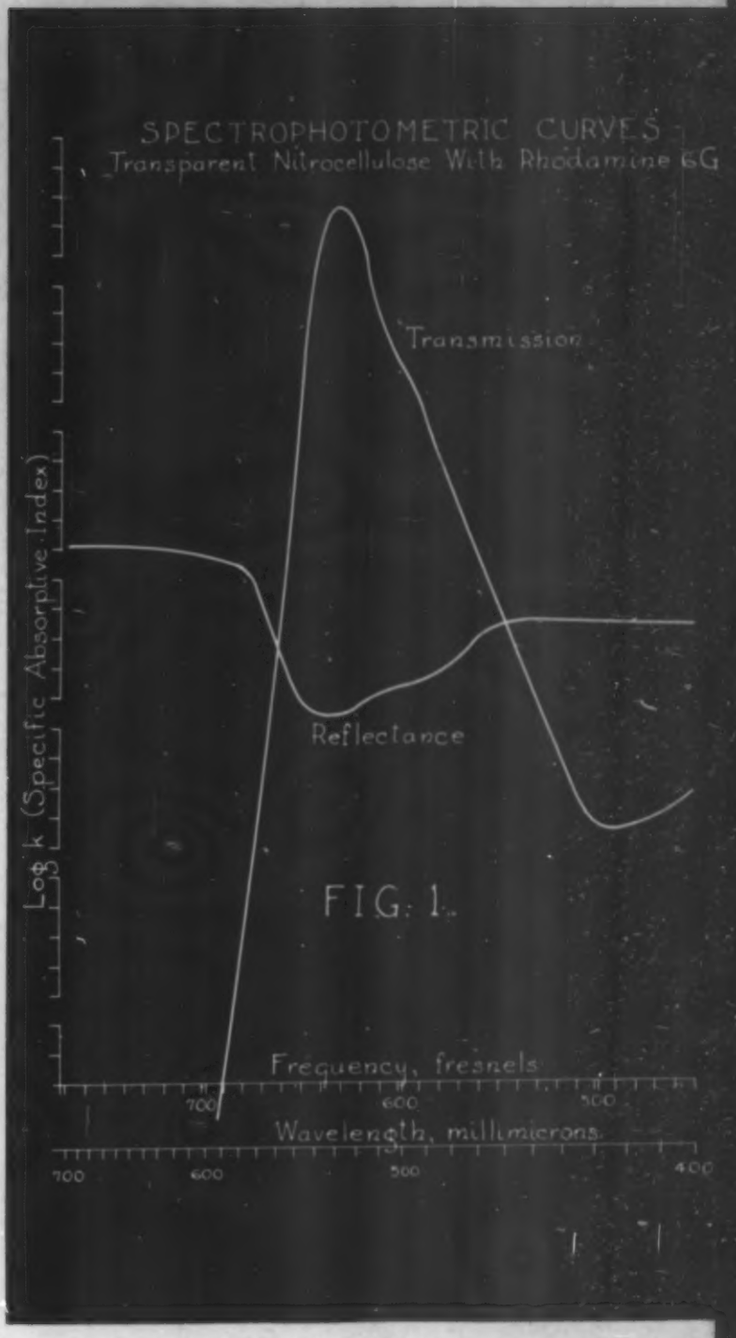
There are certain physical properties of plastics, not necessarily associated with their chemical nature, such as the transmission of light, that are of great importance to the colorist,—and incidentally to the designer. With respect to this property there are three types of plastics, namely: opaque, translucent and transparent. Each of these present different color problems.

Opaque plastics

Opaque plastics are usually colored throughout but only the color on or near the outer surfaces reflects light stimuli to the eye. Therefore, as the surface or reflecting layer is usually thin it must be strongly colored in order to reflect powerful hues. This relatively large concentration of coloring matter greatly affects such factors as gravity, dielectric losses, flow, warping, bleeding, and rubbing.

Translucent plastics

Translucent plastics are also usually colored throughout but in the case of these products the effect registered by the eye is a combination or blend produced by a mixture of both reflected and transmitted light. The dye in the interior as well as that on the surface of the plastics contributes to the color effect. The hue of the reflected light may and usually does vary from that of the transmitted light. Inasmuch as the ratio of reflected and transmitted light varies with the design and thickness of the article and the angle of vision, the matching of hues in translucent plastics is extremely difficult. Unless coloring matter identical with that in the standard is used and the uncolored plastic composition has a similar degree of translucency as standard, an exact match is practically impossible, although close approximations can be made in most commercial shapes. These considerations are of primary importance in china-effect plastics, whether naturally translucent, clouded by colloidal water, or made opalescent by pigmentation. One economically important feature of the coloring of these plastics is that only about one-tenth as much coloring matter is needed as in opaque plastics.



Explained below, this chart shows the ratio of reflected and transmitted light when fluorescent dyes are used in a transparent nitrocellulose plastic colored with Rhodamine 6 G

Transparent plastics

Transparent plastics are usually colored throughout, although many are surface colored. The full benefit of all the dye present is obtained so that very little coloring matter is necessary. The bulk of the light that reaches the eye from these plastics is transmitted light, although the amount of reflected light may be considerable at some angles of vision. The variations in the proportion of reflected and transmitted light explain why two color effects may match in flat plaques and may not match in a production shape—as for example in a clock case. Furthermore, some dyes are dichromatic, that is they appear distinctly different in hue in dilute versus concentrated solutions or dispersion. With such a dye, in a black bracelet, for example, the thicker areas may appear black but the thinner sections may appear navy blue. These color effects are sometimes referred to, in the surface coating trade, as mass tone (or "toptone") and undertone. Similar results are obtained not only by varying concentrations but by varying the depth or thickness of the piece. Thus, a bar of a cast phenolic plastic may look red, but give orange colored sections.

When fluorescent dyes are used, the ratio of reflected and transmitted light is especially important. Such dyes usually make plastics appear decidedly dif-

Vinylite Resins

Trade Mark

Carbide and Carbon Chemicals Corporation now offers "Vinylite" resins in commercial quantities

SINCE the epoch-making synthetic production of an organic chemical by Wöhler in 1828, many syntheses have been achieved. Beginning in 1914, Carbide and Carbon Chemicals Corporation has conducted an organized program of research and development and today is one of the largest producers of synthetic aliphatic organic chemicals in the world. The latest step in this program is the successful production of "Vinylite" resins in large commercial quantities.

What "Vinylite" Resins Are

The word "Vinylite" is the trade-mark of Carbide and Carbon Chemicals Corporation to identify its synthetic plastic materials, which consist of a group of thermo-plastic resins. These resins are produced in the form of a white, fluffy powder. They are odorless, tasteless, non-flammable and inert to the action of acids, alkalies, alcohols and moisture. They possess a high degree of purity and clarity, and can be formed readily into transparent, translucent or opaque articles.

Durable, yet light in weight, "Vinylite" Resins are strong, tough and free from brittleness, with tensile strengths above 10,000 pounds per square inch. They possess excellent dielectric properties. Their moisture absorption is extremely low—well below .05 per cent after 24 hours immersion at room temperatures. Articles fabricated from these resins have no tendency to shrink, warp or distort.

"Vinylite" Resins for Surface Coatings

Surface coatings made from "Vinylite" resins form an extremely tough and durable porcelain-like finish. Metal sheets coated with such coatings can be stamped, drawn or spun without breaking or loosening the lacquer film. These finishes have excellent resistance to weathering, to chemical fumes, acids, alkalies, alcohols, grease and oil, and practically all corrosive agents. An unlimited variety of colors can be secured, including delicate pastel shades.

Lacquers formulated from present available types of "Vinylite" resins must be force-dried to secure maximum adherence to metal. Air-dried coatings of these lacquers make a highly satisfactory finish on concrete but are not recommended for use on wood. Leading lacquer manufacturers have developed the formulation of these surface coatings and can furnish "Vinylite" resin finishes in commercial quantities for industrial use.

"Vinylite" Resins in Fabricated Form

Carbide and Carbon Chemicals Corporation is fabricating these resins into sheets, rods, tubes, coated paper, coated cloth and molded articles which it also sells under the trade-mark "Vinylite". The unusual properties possessed by "Vinylite" resins have created a wide demand for these fabricated forms. Our Technical Division will be glad to discuss "Vinylite" fabricated forms with industrial concerns having applications for which these products appear suitable.

"Vinylite" resins and fabricated articles are now available in commercial quantities to meet the demands of industry.

ferent in hue when viewed from different angles. Certain Rhodamines, for example, in a nitrocellulose plastic appear pink by transmitted light, but greenish or yellow by reflected light. Therefore, unless a dichroic or fluorescent effect is wanted, such dyes should be avoided in transparent and translucent plastics. These effects should be differentiated, of course, from iridescence, which is totally a refraction phenomenon, and is not caused by dye. This is strikingly brought out in Figure 1, where there is given both the reflectance and transmission spectrophometric curves of a transparent nitrocellulose plastic colored with Rhodamine 6G. It is obvious from an inspection of these curves that the color effect produced changes markedly as the ratio of reflected and transmitted light varies.

It may be well to point out to architects and decorators that colored plastics may appear quite different in hue in sunlight than in light from other sources. The increasing use of colored plastics for interior decorating together with that of vapor lamps makes this consideration important. Illustrative of such an effect is a transparent plastic colored with Rhodamine 6G which although pink when viewed by transmitted sunlight is colorless when viewed by transmitted neon light.

General methods for coloring plastics

Manufacturers of plastics usually color their binders, or blends of binders and fillers, rather than their fillers separately. Molders and fabricators use these complete molding compositions, but in addition, color the surfaces of finished articles, frequently color the binders, or use colored fillers,—particularly in the case of textiles and laminated paper.

Plastic compositions may be colored by:

a. Use of colored binders
b. Use of colored fillers
c. Use of colored binders and colored fillers
d. Dyeing mixtures of uncolored binders and uncolored fillers

Each of these operations may be carried out by using either dry or wet methods, the details and engineering problems involved varying greatly with each major type of plastic. Each shall be discussed separately in the following order:

Opaque, Curing Type Plastics.
Translucent and Transparent Curing Type Plastics.
Cellulose Plastics.
Ethylene Addition Plastics.
Natural Resin Plastics.
Casein Plastics.
Water Soluble Binder Plastics.

I. Opaque, curing type plastics

Coloring the binders

A. Dry Method. In our own laboratory it has been found that there are advantages to be obtained by precoloring the resinous binders. When this is done without the aid of solvents, resins are used that have not been as completely hardened or carried to an advanced condensation stage as is customary. Such resins can be worked in kneaders, or on the hot rolls for much longer periods than the usual two minute limit set for most curing type plastics. By using 10 to 20 parts of dye and 90 to 80 parts of resin in a steam-jacketed kneading machine or on the hot rolls, a master batch of strongly colored resin is prepared. This material is kneaded and rolled until the dye is thoroughly dispersed. After cooling, a sufficient amount of this colored master batch of resin is added to the regular composition formula to give the desired color, allowance being made for the resin added with the color.

The advantages of this process include the resulting greater uniformity of hue, greatly increased dispersion, increased tinctorial strength, better covering of fillers and definite improvement in fastness to bleeding. Several useful dyes that bleed too much when incorporated by some other methods show excellent fastness to bleeding when handled by the master batch method. Large scale batches have shown this to be the best dry method for thoroughly dispersing dyes that have a crystalline structure or which are mode shade mixtures. Light greens, blues and violets particularly give excellent results when incorporated in this manner.

B. Wet Method. Binders in alcoholic solution or in water emulsions are most easily colored by adding dye solutions or suspensions directly. The color solutions are preferably dissolved or suspended in alcohol in a stock solution kettle or barrel fitted with a portable or installed agitator. The alcohol should be put into the kettle and the dye dusted onto the surface.

In mixing a batch of this sort, dust can be minimized by first pasting or creaming the dye in a bucket or barrel with its own weight of benzol, or, in some cases, with warm phenol, glycerol or melted naphthalene. This paste should be thinned out with alcohol at 60°C. at which temperature alcohol is a quicker and more powerful solvent for many dyes. At this temperature also the very soluble dyestuffs which usually show a tendency to form gummy masses when wet with cold alcohol, quickly go into solution. This is particularly true of black. When it becomes necessary to obtain mode shades, for which usually mixtures of dyestuffs are used, solubility should be practically complete and therefore refluxing is recommended. Such solutions should be filtered or decanted to remove any small amounts of insoluble organic or inorganic impurities. These stock solutions should be used warm but may be cooled if the dye concentration is not excessive.

Sometimes cold alcohol must be used, as when necessary to cool the varnish and check the reactions. In this situation the dye is added in portions or creamed with benzol as aforementioned and stirred for longer periods. Fortunately the coloring matter need not be in complete solution if well dispersed before being pumped into the hot varnish, the excess dyestuff usually dissolving readily in the hot alcoholic resin solutions. Several dyes which are sparingly soluble in alcohol alone are readily soluble in hot alcoholic solutions of certain resins—particularly acid resins. It is sometimes possible to add coloring matter at the start of the resin manufacturing process, but this procedure is not recommended for general use.

(b) *Coloring the fillers*

The principal fillers colored are wood flours,

mineral fibers, and clays. The shade of the filler is important if the dye is transparent, but this is often overlooked as a factor. The use of reclaimed newsprint, varicolored cotton rags, or Kraft stock usually will give different color effects than when alpha pulp, bleached cotton flock or linters are used.

Many cellulosic materials can be dyed by the well known methods usual for dyeing. Usually, however, in view of the fact that the filler is to be coated, it suffices to paste the filler with a dye solution or suspension and dry. In drying, the material should be tumbled or otherwise agitated, else the dye will migrate to the surfaces, heavily staining the surface layers and leaving the lower layers almost unstained. This effect will be pronounced when dyes are used that have no direct affinity for cellulose, and will be minimized as the affinity is improved.

Mineral fillers such as asbestos and mica are difficult to color uniformly because of poor affinity. Kneading the asbestos into a dough with the dye solution and drying while agitating gives useful results. The use of dye mixtures that mutually precipitate each other, or which can be laked onto the fillers yields improved results—particularly as to water fastness. Asbestos cloth can be padded or calender stained. Asbestos yarn can be run through dye solutions. Long fibre stock and cloth are probably covered best by using dyed or pigmented resin solutions. Mica can be colored during the wet grinding process.

Some clays (and high tannin content organic materials) have direct affinity for certain dyes, particularly for the basic dyes. The clays are pasted or suspended in dye solutions and then are allowed to settle before decanting, or are filtered, dried, and ground. About two pounds of these dyes can be absorbed on 100 pounds of clay, or if suitable reagents such as tannin are used, some five pounds of dye can be absorbed on 100 pounds of clay. More dye can be added in lake form, or precipitated on the clay.

Direct Addition of Dye to Uncolored Binders and Fillers:

Probably in actual tonnage the bulk of the colored, opaque, curing-type molding powders is prepared by adding dye-stuff directly to mixtures of uncolored binders and fillers, all in powder form. Most of the blacks and many of the pigment colored browns are prepared in this manner. It requires the use of dyes with excellent and rapid dispersion, solubility, and dyeing properties. It possesses the disadvantage of giving specky results in light hues. This method consists of, first, intimately mixing the coloring matter, binder, hardeners, lubricants and fillers in a mechanical mixer; second, processing this mixture on the hot rolls or through a Banbury Mill; and third, grinding the incorporated mass to marketing sizes or for pelletizing.

During the first or mixing step, the dye is more or less uniformly distributed over the surfaces of the other ingredients, the finer dye particles adhering chiefly to the relatively larger filler and binder particles. During the second or milling step, the softened resin coats the filler particles and also dissolves or disperses the coloring matter. At this point in the process, therefore, the mass assumes a pronounced hue, although it may have appeared but weakly colored when previously removed from the mixer.

The final grinding of the incorporated mass improves the uniformity of the color dispersion. The dry mixed charge from the mixer may be finished by wet methods if hot rolls are not available, for example, by kneading into a paste with suitable solvents and drying in thin layers or while agitating.

Use of Colored Binders with Uncolored Fillers:

Occasionally, molders buy colored binders to mix with their own choice of fillers. This is especially the practice with black varnishes. If such colored varnishes are considered to be dye solutions in special solvents, it will be evident that they are applied by the methods previously discussed under the Coloring of Fillers. Generally, the colored varnishes and uncolored fillers are kneaded together and the resulting dough is dried in thin layers or while being agitated.

Sometimes a molder has occasion to use his own choice of solvents as well as of fillers. In such cases a colored binder in solid form is purchased. Directions for dissolving such binders vary with local needs, equipment and the composition. In general, they are made into varnishes, kneaded with the fillers and dried. Colored binders in solid form, however, if friable, may be powdered and dry mixed with the uncolored filler, then hot rolled.

Use of Colored Binders with Colored Fillers:

It will be readily appreciated that the most uniformly colored effects are obtained by using colored binders with colored fillers. Any blotchy areas due to partial separation of filler and binder in the final particles are less apparent. Fibrous filling material lying close to the surface, or exposed by sanding or grinding, is less visible. Poor dispersion effects in the binder are also minimized.

Some manufacturers have developed processes whereby laminating stock is prepared by suspending a resinous binder in paper pulp in a paper beater, and then making sheets from the mixture. The best color effects in these processes are obtained by using a colored resin in the beater followed by calender staining the wet end sheet. This avoids the necessity of using dyeing assistants in the beater.

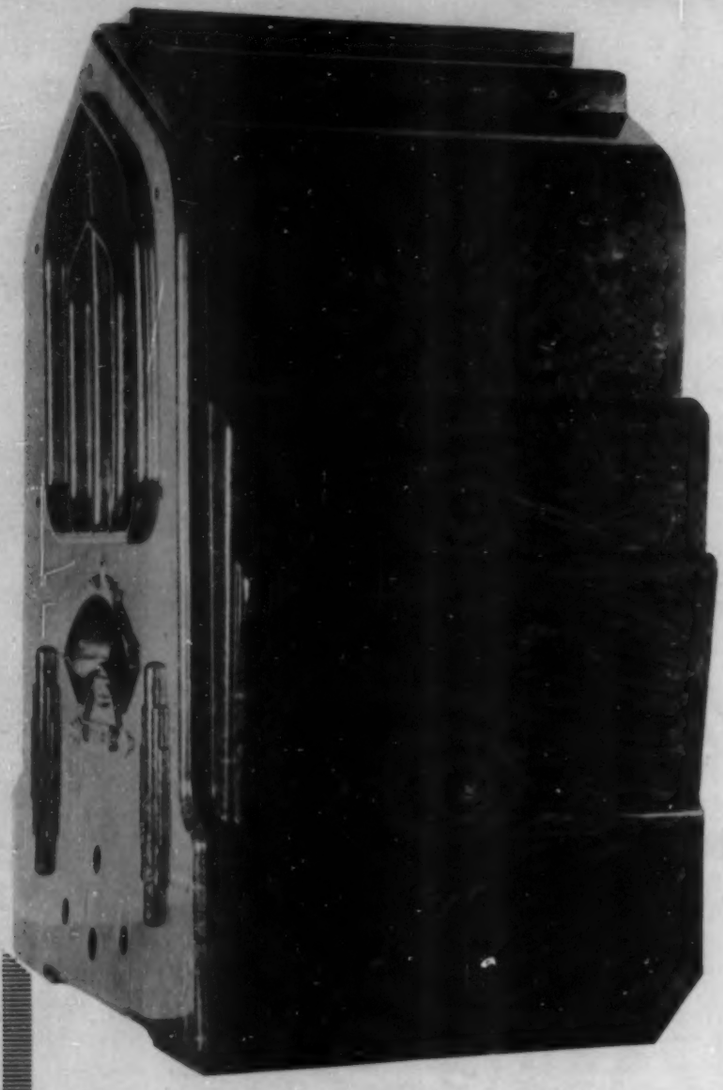
II. Translucent curing type plastics

The methods used for coloring translucent curing type plastics are in many respects similar to those used for the opaque curing type plastics. The chief differences arise from the fact that wet methods are usually employed, much lesser percentages of dyestuffs are needed, and the fastness and special requirements are somewhat more exacting. These plastics are largely of the urea-aldehyde class or else clouded transparent resins such as the cast phenolics or alkyds.

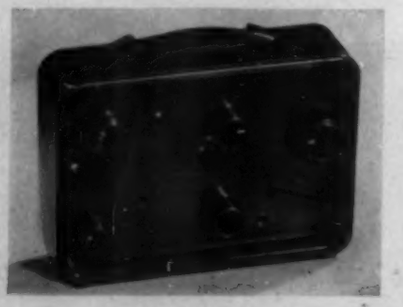
Coloring the Binders:

These binders are colored by adding solutions or suspensions of dyestuff, or by dissolving dyes directly in the early stage resin syrups. Generally so little dyestuff is required that stock solutions are rarely necessary, the requisite quantity of dye being dissolved as

But MAKALOT Did It



The big Pilot Radio—the largest ever molded in this country. After three strenuous months of unsuccessful efforts to make this most difficult molding with the other powders, the manufacturers appealed to MAKALOT. Result—within 24 hours they were being successfully made of MAKALOT.



For many long months the manufacturer struggled with warping troubles on this piece, but first trial with MAKALOT not only eliminated all warping troubles but reduced the curing time about twenty-five percent.

A Message to Molders and Users of

PHENOLIC PLASTICS

While users of MAKALOT are familiar with its advantages there has been so much propaganda by our big competitors that I decided to present pictures and absolute facts regarding a few of the difficult jobs that MAKALOT has solved.

Below each picture is the time it took MAKALOT to solve the problem and the time the molder had wasted on other materials in an unsuccessful effort to make the articles pictured herein. The names of the molders have been eliminated for obvious reasons, chief of which being that other materials had been specified but would not work.

When I became interested in the Plastic Industry I will admit I did not know what it was all about, but I soon learned that there was little opportunity for "just another molding compound"; that to get any place it would be necessary to have either Prestige, Unlimited Money, a Background where reciprocal relations could be compelled or a *Better Material*. As my company had none of the first three there was nothing left but "A Better Material."

How well we have succeeded—the pictures give the answer—also that in spite of tough competition at all times and vicious competition much of the time MAKALOT today occupies third place in the Industry. Its production of Molding Compounds increased 75% in 1934 over 1933, 70% in 1935 over 1934 and I expect 1936 will show a still greater increase over 1935 than the previous years.

We are familiar with and can produce practically every known type of Molding Resin, also the Oil Solubles, Alkyd, Paper Impregnating, Odorless, Laminating Varnishes, etc. Our Molding Com-

Yes MAKALOT Did It

pounds cover a wide range—Odorless and Non-bleeding for closures, Low Loss, Non-shrinking, Acid and Alcohol Resisting, Non-fading light colors, Shock Resisting, Arc Resisting, and our #75-H Black and Brown Heat Resisting Materials we believe produce at least 60% of the heater and switch plugs made in this country.

Much has been said by salesmen or so-called engineers of some of our competitors as to our plant capacity and financial responsibility. Therefore, prospective customers are entitled to know these facts also. While we have no golf courses, tennis courts, yachts, Lincolns, Rolls Royces or swimming pools, we do have shower baths for our employees. We only own two acres where our factory is located. It isn't as large as even "The Woolworth Building," but it is equipped to produce over 30,000 pounds of Resins and about 20,000 pounds of Molding Compounds per day and everything in it is paid for.

While MAKALOT is not "the answer to the Molder's Prayer" it has helped others and when you are having trouble, and you *all have it,* why not try MAKALOT?

M. M. MAKEEVER,
President

The "Unbreakable Nurses' Call Button". Again MAKALOT came to the rescue of the manufacturer who had developed and patented the above article only to find that none of the Plastic Materials were successful. But within one week they were being made of MAKALOT Shock Resisting Material—so strong that the manufacturer now shows a picture of the "Call Button" being thrown from the roof of their six floor factory and lighting on the concrete of their shipping yard with but slight damage to the Button.

Six months were spent by two Plastic manufacturers in an unsuccessful effort to supply a satisfactory material for this job. It took less than one week and the third sample for MAKALOT to Lick It.

Walls so thin in places and thick in others only MAKALOT would successfully make it.

The big Universal Winder, the largest and most difficult job of Extrusion Molding ever done in this country, had to be made of MAKALOT. Nearly three months were wasted by the molder on this job before he decided to try MAKALOT. Result—within 12 hours MAKALOT got him out of the "jam".

On this Christmas Socket two molders and three materials failed, but within 48 hours MAKALOT Licked It.

MAKALOT CORPORATION
262 Washington Street, Boston, Mass.
FACTORY, Waltham, Mass.

needed in some suitable small container. For this purpose, glass or nickel vessels are preferable to wooden containers as wood tends to absorb some of the dyestuff, which may later bleed out and contaminate succeeding solutions. The dyestuff should be pasted with its own weight of solvent, creamed out and diluted.

Insoluble coloring matters are difficult to introduce into water soluble binder syrups, as such products have a tendency to settle out and cake. Insoluble dyes in colloidal dispersions are preferable to inorganic pigments in this respect.

Coloring the Fillers:

The filler materials useful in transparent plastics are selected from those products that least affect the translucency and specific gravity. Accordingly most of them are organic materials, particularly cellulosic, rather than mineral products. The methods used to color them are similar to those already discussed.

Use of Colored Binders with Uncolored Fillers:

These are applied in kneader machines as with the opaque curing type plastics. The use of Alphasol OT or other good wetting agent, with unsized fillers improves the penetration and bond between the binder and fillers. Colored, powder-form varieties of these binders are rarely available, and when obtained should be used according to instructions from the manufacturer who supplies them.

Use of Colored Binders and Colored Fillers

In some applications both colored binders and colored fillers are used. By this means there are obtained decorative effects not readily procurable by the use of only dyed fillers or only dyed syrups. Because of the translucency of the materials, the hue of the dyed filler is modified by and in turn modifies the hue of the binder. Again both have their hues further modified by the curing treatment, as well as brightened and intensified by the light effects characteristic of translucent solids. Accordingly the original hues of the filler and the binder are not determinate, nor too important, providing the hues of the finally cured plastic are those desired.

Use of Colored Fillers with Uncolored Binders:

In special applications, colored fillers are mixed with uncolored binders. With fibrous fillers this is usually done in a kneader, after which the mass is dried. Dyed fabrics or paper are run through binder syrups in a trough, then through squeeze rolls and dried. This process is used for preparing laminating stock, or with dilute binder syrups, for water-proofing and crease-proofing fabrics[1].

Usually, the fastness to light requirements are high, both for crease-proofing fabrics and laminated stock. In practice it is more often possible to get greater fastness to light by coloring the filler than by using colored binders alone. Although many of these binders are poor transmitters of ultra violet light, it is found that most coloring matters fade rapidly in this type of plastic on exposure to light.

Coloring Mixtures of Uncolored Binders and Uncolored Fillers:

Mixtures of uncolored binders and uncolored fillers are colored in a manner similar to that already described for opaque curing type plastics. Although most of the early production in this field was by wet methods without heating, and such methods give results which have not been greatly improved upon insofar as color effects are concerned, a large part of the modern production is colored by dry grinding coloring matters directly into finely ground uncolored compositions. This method affords some production economies[2].

III. Transparent curing type plastics

Commercially important transparent curing type plastics are such products as cast phenolics, cast alkyds, molded ureas, and molded phenolics. At the present time these plastics are used largely without solid fillers. Being transparent, they require very low percentages of dyestuff, in some cases as little as .001% being sufficient. It is necessary, therefore, to color them during the manufacturing of the resin.

Cast Phenolic Resins:

Coloring matters are added to cast phenolic resins preferably as late in the process as is practical. Many water soluble and spirit soluble dyes are used. The spirit soluble dyes are added dissolved in alcohol, or glycerine. Occasionally, some oil soluble dyes are used dissolved in low boiling hydro-carbons. Other dyes are dissolved in water and occasionally in phenol. Dye solutions for pastel hues should be filtered.

Insoluble dyes and pigments may be added, preferably as colloidal dispersions in glycerine. Often these coloring matters are used in producing some of the beautiful, contrasting cloud effects seen in these plastics. The specific gravity of these colors and pigments is important, particularly if they are added to thin pouring batches.

Because of the minute percentages of dyestuff used, the control of hue is difficult. In certain cases the self shade of the resin and changes occurring therein may be as great or greater in effect as the color induced by the dye. Sometimes obscure chemical reactions are responsible for color changes even with inert pigments. A good example of this is the deleterious effect on light fastness of titanium dioxide-glycerine reactions[3]. Careful laboratory and plant control is therefore required. Extraneous dust and dirt must be rigorously avoided.

Alkyd Resins

In the case of alkyd plastics, the dyestuff frequently is added early in the process. This is safely possible because, although it is not well known, phthalic anhydride in a molten condition is one of the most powerful solvents for dyestuffs. Hot glycerine also dissolves many dyes. Accordingly, it is more frequently safe practice with these plastics to add the dry dyestuff directly to the reaction kettles. Additions of dyestuff at somewhat later stages may be made. The dyestuff then should be in complete solution or in a finely divided dispersion.

This type of plastic attacks dyestuffs more vigorously than any of the others, making the control of hue extremely difficult. Many dyes will appear apparently unaffected during the A stage polymerization, only to bleach out during the B stage cure which latter step

sometimes requires months of heating. It is not surprising therefore that few dyes remain stable.

Moldable Transparent Phenolic Plastics:

This type of plastic is a recent development, normally possessing a strong yellow self shade, although some recent products have been made with very little self shade. It is impractical to color the yellow varieties to yield good blues, and certain pastel effects. The lighter colored types can be colored practically to all hues. Owing to the tendency of these plastics to darken, dyes of limited fastness to light may be used, but they should be bright in shade. The small quantities of dyestuff used are best added in solution. Transparent toners can also be used as dispersions in a suitable vehicle, such as melted naphthalene. The dye solutions or dispersions are best added shortly after the start of the second stage or at the corresponding point in the one stage process.

Moldable Transparent Urea Plastics:

The moldable urea derivatives are also recent developments. These are colored at various stages, using dye solutions, or dispersed transparent toners. Fastness to light requirements are high.

IV. Cellulose plastics

These plastics use, as the principal binding agent, such cellulose derivatives as nitro-cellulose, cellulose acetate, cellulose ethers, and regenerated cellulose.

The coloring of these nitro-cellulose plastics is closely akin to the coloring of lacquers,—in fact many of them could be considered as lacquers thickened with more or less solid plasticizers. Spirit soluble dyes are often used and are dissolved in alcohol, filtered and added to the thin masses in a kneader type mixer. Certain blacks are preferably dissolved in mixtures of solvents, such as of alcohol and benzene. The addition of traces of certain organic acids is also recommended, although patented. Blacks are usually added in the kneader in which scrap and reworked nitrocellulose is dissolved. Sometimes pale hues are colored on the warm mixer rolls. By using a suitable choice of solvents for the dyes or colored lacquers, articles can be surface colored.

Insoluble coloring matters are preferably added as pastes ground in castor oil or other softening or plasticizing agents. These pastes are thinned out with a little alcohol or benzene and added immediately to the doughy mass in a kneader type mixer or on the rolls. Usually the vehicle used in these pastes is retained permanently by the plastic so that its physical effects should be considered when formulating. The use of pre-ground pastes can be eliminated by mixing the color directly with dampened nitrocellulose and subsequently working into a suitable plastic magna.[4]

Coloring matter should be selected that does not hydrolyze or otherwise decompose to yield products that may attack or catalyze the decomposition of the nitrocellulose. Some dyestuffs profoundly affect the viscosity and other properties or react with some of the organic salt plasticizers often used.

Cellulose acetate plastics are colored by methods similar to those used in coloring the nitrocellulose plastics. There are, however, some definite differences in procedure and formulation to which attention should be directed. These differences are: the higher temperatures which may safely be employed, the more limited use of alcohol, and the entirely different plasticizers remaining as permanent components. The differences cited must be considered when selecting dyes for coloring these masses. It should be noted that many dyes useful in nitrocellulose plastics will not readily disperse, nor color attractively, nor stand the warmer processing of cellulose acetate compositions.

Unlike nitrocellulose, other cellulose esters can safely be produced as fine powders. R. O. Wood[5] has taken advantage of this fact and has patented a process for coloring cellulose ester plastics with spirit soluble colors. In this process the colors are dissolved in suitable plasticizers, such as ethyl paratoluene sulphonamide, and blended in the ball mill with the powdered ester.

Cellulose ester compositions may also be colored by using pre-colored modifying resins. Solutions or dispersions of coloring matter in these resins will diffuse or disperse throughout the mixed magma. Insoluble coloring matters are ground until very finely divided into selected plasticizers, such as diethyl phthalate, and the pastes added to the dough mixture.

When fillers are used they may be dyed with fast dyes and/or merely stained with dyes designed to bleed into or be picked up and dispersed by the cellulose ester on admixture and during further processing of the material.

Cellulose acetate plastics are also extruded as yarns, the bulk of which are used uncolored or else dyed by the textile dyers. These yarns when woven into cloth, uncolored, dyed or printed, are sometimes used to obtain special design effects in cellulose plastics[6]. They are also used in the Trubenizing Process for stiffening and wilt-proofing fabrics[7]. Cellulose acetate solutions also may be colored before being extruded through the spinnerets. Transparent dyes, colors and toners yield transparent lustrous yarns, except in strong shades. Insoluble coloring matters yield the more or less opaque, delustered products. In general only solid color effects may be obtained. There are still many problems involved in these processes, as for example the effect of delustering agents upon the light fastness of coloring matters[8].

Cellulose ethers, as for example methyl, ethyl and benzyl cellulose, are probably used more in lacquers, inks or other surface applications than in plastics. They are, however, finding increasing use in special plastics particularly in mixed binders. Dentures may be cited as one such field. These cellulose derivatives are colored by the various methods discussed under cellulose esters, the choice of coloring matter and application method varying with each specific usage.

V. Ethylene addition plastics

Plastics in this group are such ethylene derivatives, as the aliphatic and aromatic vinyls, vinyl esters, vinyl halides and divinyls. Many of them are used as clear glass-like products, undyed or but slightly blued. When colored, dyes soluble or dispersible in aliphatic hydrocarbons are used, the oil soluble colors are par-

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ticularly suitable. Most of these plastics, being thermoplastic, are easily colored by direct addition of dyes and pigments on the hot rolls. Colored fillers also may be employed. When these plastics are used as rubber substitutes, they are colored by the methods and with the coloring matters used for rubber.

VI. Natural resin plastics

Natural resin plastics such as shellac bonded phonograph records are best colored by adding the dyestuff to the resin alone on hot rolls, and then adding the other ingredients. This premilling favors better dispersion of the dye, and so affords some measure of economy. Moreover, it favors certain resin reactions some of which are decidedly beneficial to the "life" and flow. But with many dyes this process is deleterious, products forming which accelerate or catalyze polymerization as is the case with certain dyes and shellac.

A large amount of the production in this field is colored by dry mixing or screening the dyestuffs into a finely powered mixture of the fillers and binders. Such mixtures may be then hot rolled, or, in specialized applications, may be used without further processing. In the latter case care should be exercised in transporting such mixtures, as from one department to another, in order to avoid separation of high gravity fillers or the formation of balls and pellets of the low gravity ingredients.

Natural resin plastics for phonograph records usually contain less than 5% of fibrous matter, because of the danger of their projecting into the sound tracks, so that most of the fillers are mineral. These all have some self color, which of course modifies the final hue. Bright color effects therefore are difficult to obtain without the use of some white pigment to replace a portion of the other fillers. Dyes for record stock should be capable of being absorbed on the mineral fillers present, and should favorably affect such properties as gloss, flow, warpage and surface. They should be stable enough to be used in either virgin stock or reworked flash. In the case of blacks, carbon blacks have been used for years but owing to their lesser effect on flow and resin absorption, dyes are now being used in increasing volume.

Natural resin plastics, not destined for sound records, use all the miscellaneous fillers available, both fibrous, fabric and powdered, and in large proportions. These plastics are processed by dry methods as on the hot rolls, or by wet methods employing spirit varnishes. Usually a larger percentage of white pigments may be incorporated in these plastics than is advisable in sound record compositions, so that moderately bright color effects are possible.

Bituminous binders are used in large quantities in "cold molding" compositions. These are all black or brown products so that only dark shade effects are customarily obtained. When the self shade of the binder is brightened and lightened by using white pigment fillers some mode shades are obtainable, but large percentages of dyestuffs or pigment are required. Dyes soluble in aliphatic hydrocarbons can be used, as well as tinctorially powerful toners.

VII. Casein plastics

Casein plastics are colored at various stages of their manufacture. Generally, "acid dyes" are used, as they have direct affinity for protein matter, especially in acid solutions. For special applications however, the use of other types of dyes is increasing. As casein plastics are usually horn-like materials with considerable translucency in thin sections, relatively low percentages of dyes are required. The coloring matters used should tend to dye casein thoroughly or their fastness to bleeding may be adversely affected. The processing temperatures are low, particularly during the hardening process, so that many dyes not stable enough for other plastic fields are available for this work.

The coloring material is preferably added on mixing rolls, or in kneader type mixers. Soluble dyes are dissolved in water, filtered and added to the wet mass. Insoluble dyes, colors or pigments, are added as colloidal dispersions. Dye solutions are frequently applied to the pressed or extruded materials to produce vari-colored effects. Usually, considerable penetration of dye is required as the outer surfaces are later machined or polished.

Casein plastics are sometimes colored in the hardening baths. Dyes for such application must be fast to formaldehyde, have good solubility, affinity, and penetrability. The penetration of dye mixtures, such as are used for mode shades, must be uniform or the interior hues will vary from the surface hues. It may be worth noting, however, that occasionally such variations of interior and surface hues are deliberately designed.

VIII. Water soluble binder plastics

No field of plastics uses a wider assortment of raw materials than the group made with water soluble binders. These plastics can be colored by dyeing the binders, mixing coloring matter with the other fillers, dyeing the fillers, grinding dyes or other coloring matters into the pulverized composition or by surface decoration.

Sometimes these plastics are hardened, as with formaldehyde, heat or hydration reactions. Many must be made with materials of U.S.P. purity and be non-toxic. Non-toxic requirements, in the United States, ordinarily mean that the choice of dyes for them is limited to those on the certified list. Fastness requirements vary greatly.

For dye application purposes the water soluble binders may be grouped with reference to pH. Some of the binders most often used in alkaline solution are: Caseinates, alginates, sodium and other soluble salts of natural resin acids, latex and resin colloidal dispersions, glycerine borates, lecithin, carnauba wax-shellac emulsions, nitrocellulose emulsions and silicates. Ammonia, caustic alkalies, soap, urea, borax, sodium betanaphtholate, lime and sodium phosphate are the alkalies used.

Glues and gelatines, and most of the urea resin binders are used in the presence of dilute organic acids, such as formic, acetic, oxalic, citric, and cresylic acids.

Albumen, gums arabic, tragacanth and karaya, starches and dextrines are most often used in practically neutral solutions. The most difficult group to dye is the protein binders in alkaline solutions. For

this purpose the following acid dyes are used, when fastness to light is not of paramount importance:—Eosine, Rose Bengale, Metanil Yellow, Alizarine Cyanine Green, Brilliant Wool Blue FFR, Violamine 2R, Sap Browns, and the so-called alkali proof water soluble Induline (navies) and Nigrosine derivatives for blacks. Insoluble coloring materials for alkaline binders include Ultramarine Blue, Monastral Blue, Cadmium Reds and Yellows, Chrome Green, Ochre, Burnt Umber, Burnt Sienna and Carbon Black. These are all very fast to light.

Fillers dyed with sulphur dyes, vat dyes and some direct dyes are stable to both acid and alkaline conditions. By using fillers colored with these dyes and using similar shade dyes in the binders (or transparent binders) fast to light effects are obtained without the use of pigments.

Many of the neutral binders such as starch and gum arabic are used to form more or less flexible coatings (sizes) on textile yarns or are used to bind colors in printing textiles. Accordingly their effect or lack of effect upon most dyes is well known. Used in plastics, however, they require preserving agents to prevent mildew and fermentation, and these preservatives affect some dyes.

Some silicates, gypsum, and cement bound plastics are colored by dry mixing the binder with lake and earth pigments. Occasionally powdered colored glass or colored silicates are added. Soluble dyes have a tendency to come to the worked or evaporation surfaces. Oil, wax, and emulsion surface treatments protect and improve the appearance of this type of plastic. Especially is this true of those which contain salts that effloresce and give mottled effects.

Color problems and defects in plastics

Practically all plastic products must pass rigid requirements as to general appearance. There are not only such questions as the further improvement of appearance, shade matching, and the introductions of new shades to be considered but also such "trouble shooting" problems as shade variations, surface defects, interior shade changes, etc., to solve.

Visible defects in molded or fabricated plastic articles disclosed during the final inspections arise from many sources. Although discovered after molding or machining many types of defects originate in other stages of the manufacturing process and are not due to the coloring matter used although frequently attributed thereto. Some of the major tinctorial defects encountered will now be considered.

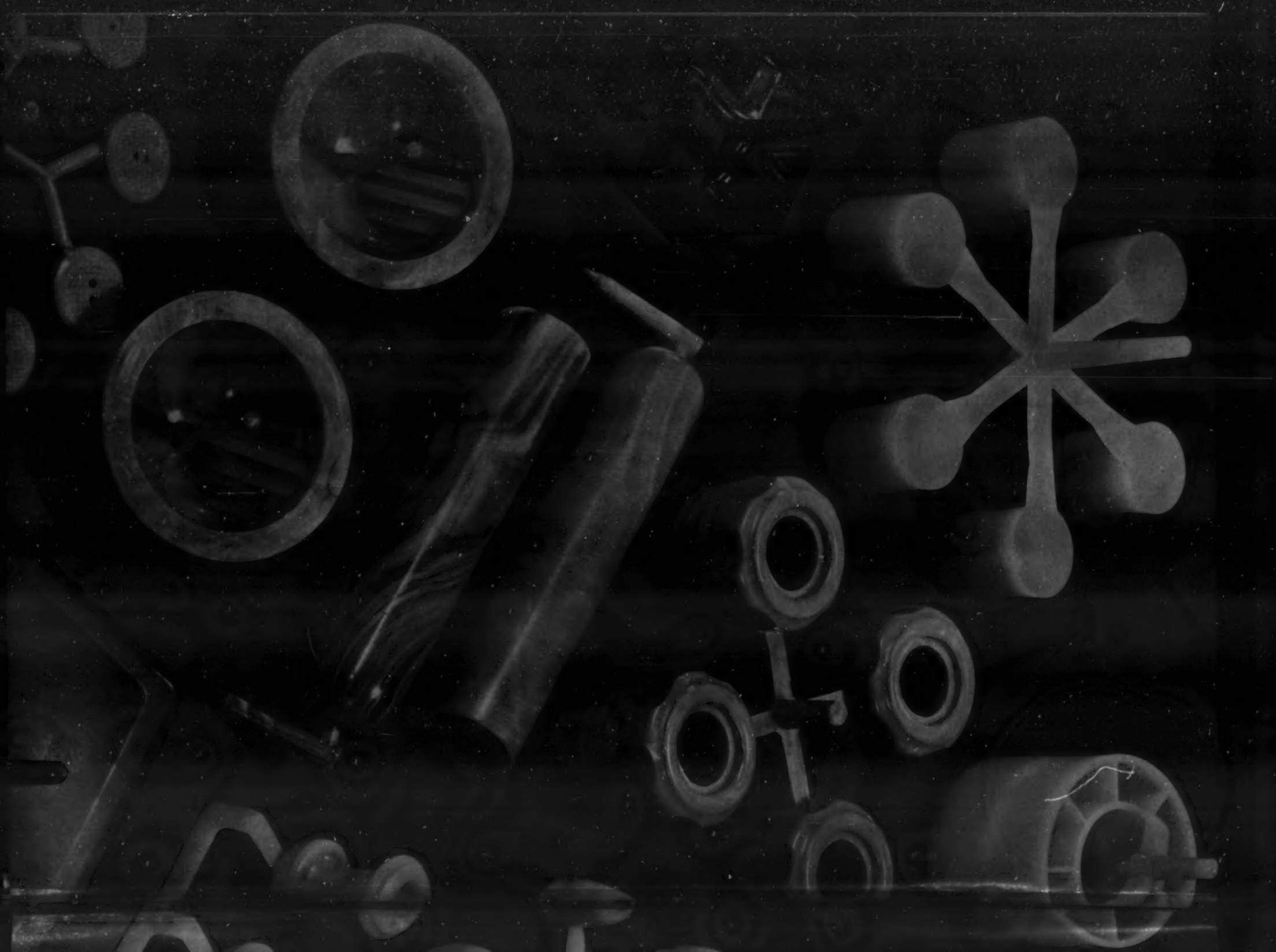
Uneven color effects may appear as specks, blotches or lines. Specks may result from poor dispersion of any ingredient, tramp dirt or color dust, mixtures of unfluxed light and dark colored binders, variations in shade between binders and fillers, use of fillers of too widely varying self shade, dirty lubricants. Blotches, that is light and dark mottled areas, may occur due to: thick and thin spots or flocks, particularly in laminated sheets; poorly dispersed white or light colored pigments; hot and cold spots in molds; dirty machine lubricants; partial separation of binders and fillers; gas bubbles near the surface; rough spots on the molds; trapped gases on the surface during molding; use of unstable coloring matters; stained or unevenly polished molds and platens; and polishing burns. Lines, frequently appearing as cellular-like markings, are caused by partial separation of binder and filler, pellet markings, flow stresses, and the use of mixtures of old and new stock with widely varying flow characteristics.

Uneven coloring may also result from variations of heat and pressure during the molding operation. Hue differences between center areas and peripheral sections are frequently encountered in large panels and pieces. One cause of this effect is the differences of temperature between the edges and those areas nearer the axis of pressure. The material in the center is often heated more quickly, and therefore for a longer period of time, than the boundary portions. Another cause is the location of the heating units or steam channels resulting in "hot" and "cold" spots, and inducing irregular transfer of heat. Pressure variations are particularly observed in panels and articles molded in open type molds. The use of too convex platens, molds mounted off the axis of pressure, too great play in the press, variations in the line pressure, and poor flowing compositions are the commonly encountered pressure variations. In transparent plastics, internal strains set up by the variable compression may result in lens-like effects.

Uneven hue may appear where thin and thick sections are found in the same piece, or articles are assembled from molded parts of various dimensions, molded under different curing cycles. For example, a box lid or a button set may be cured in two minutes, whereas the larger companion pieces, the box or the buckle, may be cured for ten minutes. Hue differences, except in dark shades, may be met with in the longer cures either through lack of resistance to prolonged curing on the part of the dye, or through self-shade changes in the resin or other ingredients. The choice and proportions of dyes used therefore, in the longer cured pieces may often require adjusting, much as the flow and curing properties of the binders are adjusted.

It will be found that many coloring matters will give a different hue on the surface of a molded piece than in the interior—regardless of the metal used for the mold or casting block. This result is difficult to explain. This effect is usually of considerable importance in opaque plastics, particularly when the surface is given a sanded or matted finish, or the articles are machined, ground to size or scratched and abraded in handling. In order properly to respond to buffing and polishing operations, the exposed interior areas when polished, must closely match the finished outer surface of the piece.

Many molded articles, such as dyed closures, container, button and buckle stock, must be fast to bleeding, laundering and dry cleaning. Practically no organic coloring matter is absolutely fast to bleeding when refluxed with alcohol and water for twenty-four hours, unless completely encapsuled by protecting binder coatings. The inorganic coloring matters bleed occasionally in contact with acidic reagents, but in general, they are rated fast. Many organic dyes are fast to water and to cold alcohol. Bleeding can be minimized by thoroughly dispersing the dye, as by



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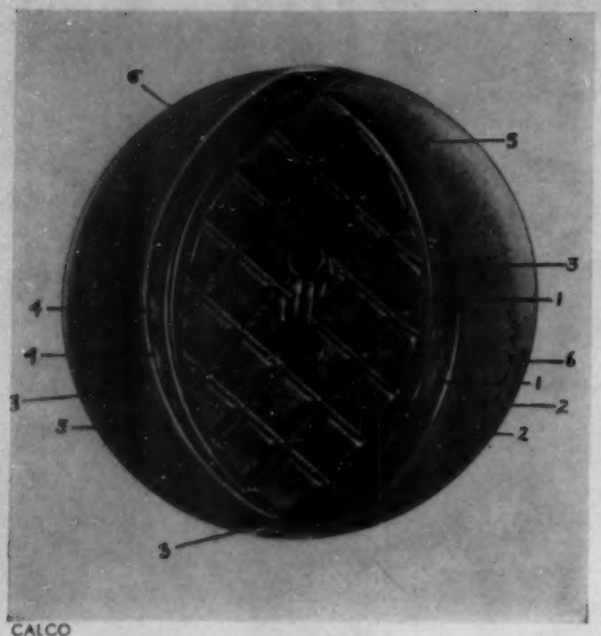

Fig. 2
Button molded in experimental mold considerably worn by use, showing various visual defects observed in molded plastics
1. Rough spots on mold 2. Poorly pulverized stock 3. Tramp dust and fibers 4. Over cured stock 5. Separated binder 6. Undispersed, uncoated filler

using the master batch method of incorporating the dye; thoroughly curing the articles,—green stock always bleeds; using pastel hues; and clearing the molded surfaces of any loosely covered or adhering dye with a light bleaching treatment with chlorine solutions, sodium hydrosulphite, or a light scouring. Sometimes surface coating the articles, as with a colorless vinyl resin, will seal in the dye. Fast to bleeding compositions require costly dyes, are expensive to prepare, and require careful molding, machining and finishing. Such premium quality products should command premium prices.

The formation of pits or holes in a plastic may be caused by (a) projection of undispersed ingredients through the surface and their subsequent evacuation or tearing out in the finishing operation, (b) mold imperfections; (c) breaking through of thin walled gas pockets while sectioning or finishing; (d) decomposition of the binder or of the dye. Certain dyes hydrolyze or otherwise split off by-products that actively attack or catalyze changes in the plastic mass. Some dye hydrochlorides, for example, liberate acid locally, producing such effects as to change a speck of convertible phenolic resin to a non-convertible type and to liberate nitrogen oxides from nitrocellulose.

Gelation in binder solutions is a phenomenon familiar to the paint and varnish trade as "livering." In plastics, it is caused by ingredients that accelerate the local polymerization or precipitation of the resinous or other type binders. This may result from catalyic or photochemical action but may also, in certain few cases, be caused by dyes. Thus some basic dyes may catalyze the polymerization of certain natural resins, and poorly made tannate lakes may gelatinize albuminoid or gelatine binders.

Fig. 2 illustrates several of the typical visual defects frequently encountered in molded plastics which occasionally are considered solely as coloring defects but which careful examination reveals are due to a variety of other causes.

Special color effects

Many of the practical processes for obtaining special color effects have been patented by the many workers who have studied such problems. Most of the effects desired have been either to imitate some natural products, to produce varicolored mottle effects or to obtain surface designs. The most attractive imitative products have been made with nitrocellulose plastics. Outstanding reproductions in this field are the mother of pearl, tortoise shell and artificial ivory and horn effects[9]. In the laminating field some excellent wood grain effects have been imitated[10]. Onyx simulations have been made with cast resins.

Varicolored or mottle effects are produced by molding differently colored lots of material in the same pieces[11]. Mixed powders give feathery edged areas while mixed tablets, flakes, bars, ribbons, strings or other preforms or extruded shapes give more sharply defined color areas. Some attractive effects in cast resins are made by partly curing castings, machining them to various shapes, then casting around them more material of contrasting or harmonizing color[12]. Cloud effects are obtained by skillful manipulation in simultaneously pouring two or more differently colored lots of plastic into the same mold. Some novel effects have been obtained by molding or casting transparent binders around colored cheese cloth, metal objects or other unusual fillers.

Exact design effects are obtained in several ways, e.g. by using hard pressed and slow flow preforms, or by molding new material around partly cured stock.[13] In laminated work, printed paper or calico or fancy woven cloth is impregnated and used as top or second sheets[14].

Valuable miscellaneous effects such as obtaining contour and relief designs[15] on laminated stock have been accomplished. The use of metallic inlays, particularly with colored metal, is receiving increasing attention. C. W. Revise[16] and C. Ellis[2] have compiled a list of patents covering these special colored effects in detail.

It is hoped that this discussion has served to disclose the extensive scope of the problems encountered in coloring plastics, with the object of stimulating additional technical and scientific attention to this important phase of plastic manufacture. The discussion, therefore, has been broad and necessarily sketchy, detailed consideration of the problems of any one field having been left for future treatment.

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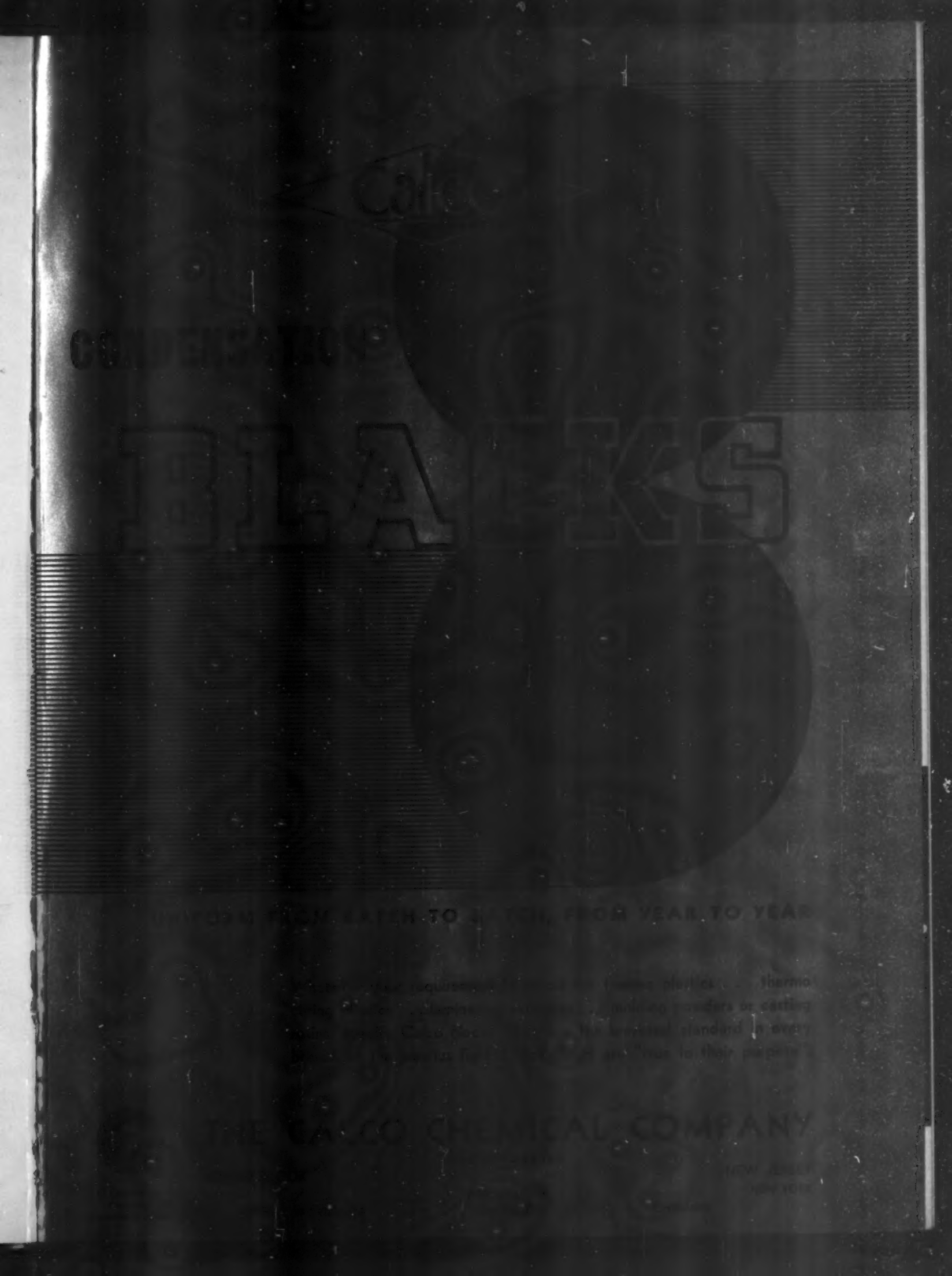

BLANKS

Urea formaldehyde

(*Continued from page 21*) lines, without incurring additional tool expense.

The applications to which urea materials have been turned give conclusive evidence of the versatility of these compounds. In such applications, while the unique qualities discussed above are important, appearance, color, and decorative qualities account more often than not for the use of ureas.

Space forbids a complete listing, and today's list would be out of date tomorrow anyway. But it might start with buttons and buckles, in the manufacture of which color, rigidly held to standard, is of importance. Closures from tiny caps for 8 m.m. perfume bottles to 100 m.m. jar caps are molded in large quantities, as are premium items (such as the 7 million biscuit cutters and 10 million cereal bowls distributed by one company), and the familiar adult and children's tableware and bathroom fixtures sold at retail. Mention should also be made of containers and packages of both good and bad design (frequently a designer forgets that he is working with a new fundamental type of material) for such diverse items as cleansing creams, shaving soap, tissue paper, fruit cake, watches, fountain pens, and pharmaceutical products; radio and clock cases, electrical wall plates and outlet plugs. Millions of automobiles are dressed up with urea knobs and dash panels, and it is difficult now to find a stove manufacturer who does not use colored urea handles for his product.

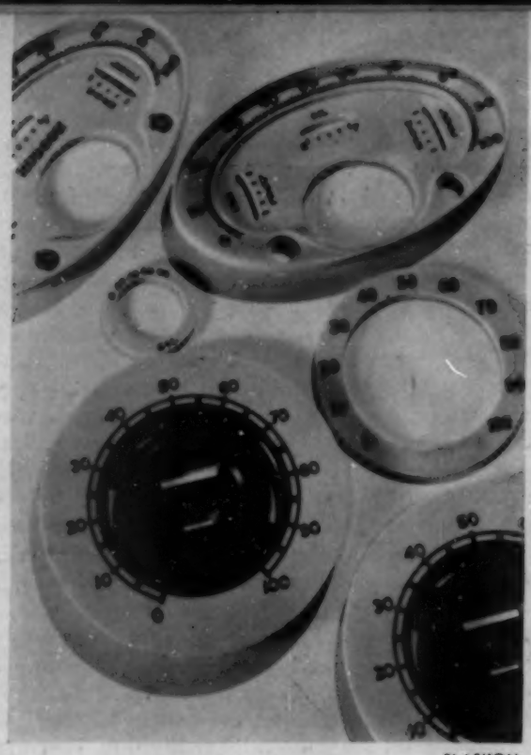
Brief mention might also be made of the large butchers' scale housing manufactured of urea material during the past year. This, one of the largest moldings ever fabricated in production quantities, was instrumental in cutting the weight of the old type scale from 165 pounds to 55½ pounds, and in increasing sales of this type of scale some 300 per cent in the first year of its manufacture. The successful molding of such a large piece (total weight approximately 9 pounds, dimensions 15¾ by 17¾ by 15⅜ inches) gives rise to the prediction that molded ureas will be used more and more for large housings, since in addition to the very considerable reduction in weight, the housing has a finish which is an integral part of the molded piece.

An interesting development in the urea plastics field in the past 2 years has been the adoption of this material by lamp manufacturers, to replace glass. Urea materials in natural unpigmented form are very highly translucent. They give high light transmission with an exceptional degree of diffusion. This feature together with low unit manufacturing cost makes molded urea ideally suited for semi-indirect lighting fixtures where a balanced central and peripheral visual value is desired. In addition, molded urea shades and reflectors are shatter-proof, and being considerably lighter in weight than similar glass pieces, bring down shipping costs appreciably.

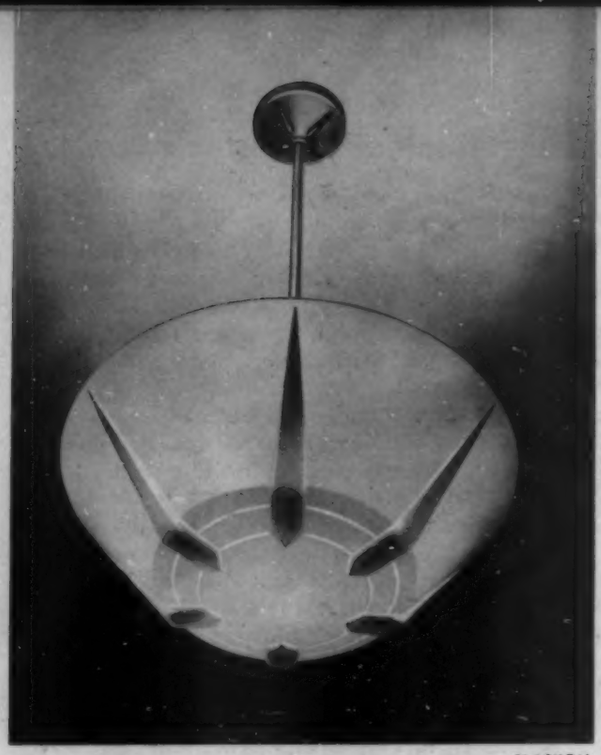
The ureas offer the lighting industry a material remarkable for its adaptability to the lighting problems at hand. Because the raw material can be sup-

BEETLE

Picnic sets of brilliant colorings make use of ureas as do hundreds of individual items in the retail stores



PLASKON



PLASKON

BEETLE

Above—Instrument board dials of urea plastics with wiped in numerals and letters. Below—The new Gem razor box of white urea

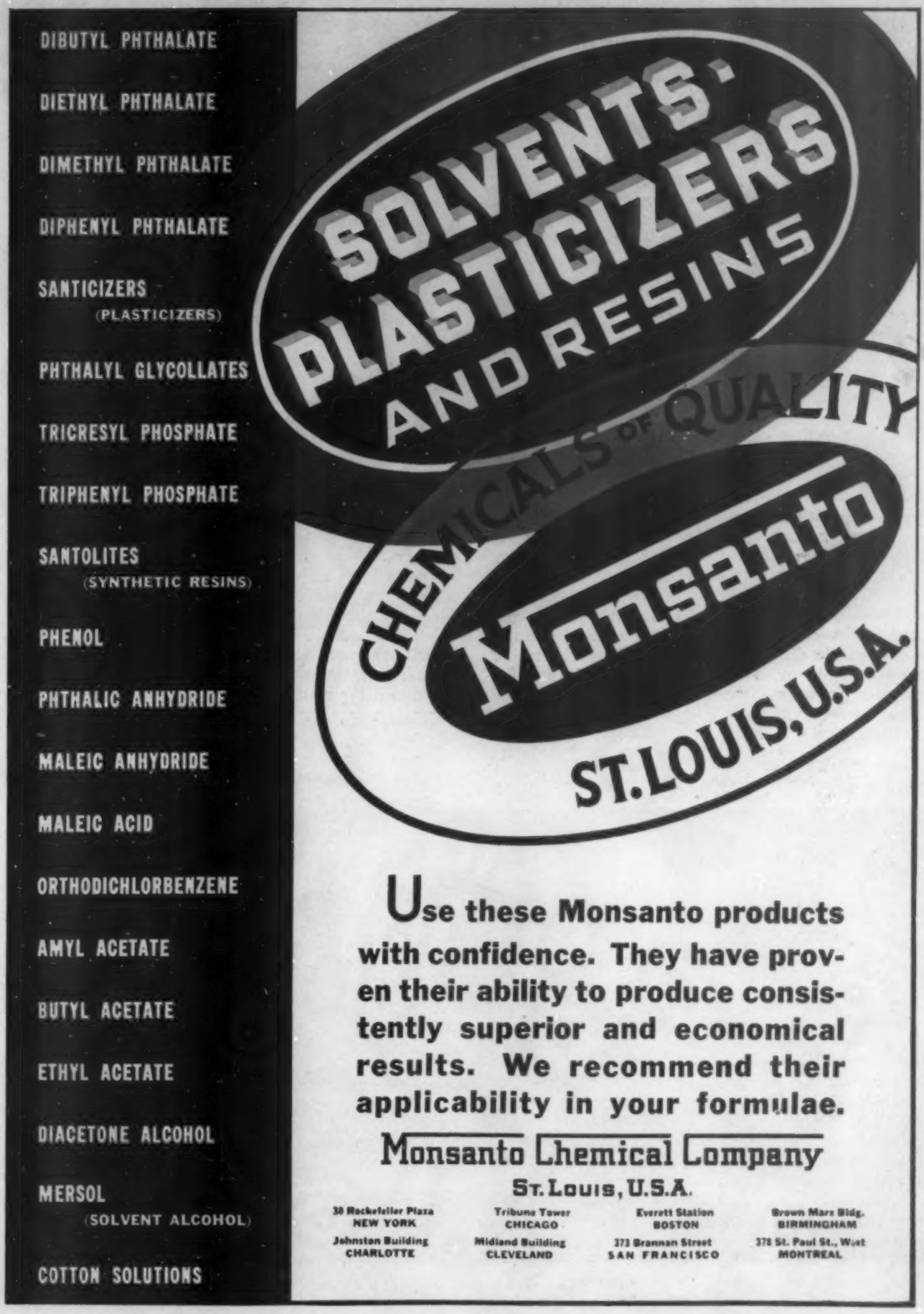
Above—Translucent urea is being rapidly developed in the lighting fixture field for home and industrial lighting. Below—Ring and rouge boxes of Plaskon

plied in a varied degree of denseness or capacity, molded pieces can be made of material which will give the particular ratios of reflection and transmission desired. If high reflection is desired, any degree can be obtained up to 80-85 per cent. If high surface brightness is required, a more natural or translucent material is used. The color of the light can also be widely altered. The urea's ability to meet varied needs in lighting best illustrates its adaptability. At present ureas are being used for I.E.S. diffusing bowls for floor lamps and study lamps; it is being used for reflectors as large as 21 in. in diameter, and also for decorative shades on light clusters.

The accompanying table will indicate in a small way the variability obtainable in the ratios of light transmission and reflection from several typical moldings. This data was furnished by the Electrical Testing Laboratories, August, 1936. Measurements of transmission were made with diffuse light incident upon one surface of the sample. The total light emitted in all directions from the second surface, was observed. Tests were conducted on flat urea discs of 2¼ in. diameter.

Table

Sample and Thickness		*Reflection Factor*	*Diffuse Transmission Factor*
Pearl (A)	.038	0.47	0.42
	.069	0.49	0.27
	.091	0.51$_5$	0.23
Pearl (B)	.043	0.44$_5$	0.46
	.068	0.50	0.32
	.087	0.54	0.27
White	.038	0.77$_5$	0.14$_5$
	.068	0.79$_5$	0.08
	.087	0.81$_8$	0.05$_5$
Ivory	.039	0.64	0.26
	.068	0.68	0.16$_5$
	.086	0.69	0.12$_5$


DIBUTYL PHTHALATE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
DIPHENYL PHTHALATE
SANTICIZERS (PLASTICIZERS)
PHTHALYL GLYCOLLATES
TRICRESYL PHOSPHATE
TRIPHENYL PHOSPHATE
SANTOLITES (SYNTHETIC RESINS)
PHENOL
PHTHALIC ANHYDRIDE
MALEIC ANHYDRIDE
MALEIC ACID
ORTHODICHLORBENZENE
AMYL ACETATE
BUTYL ACETATE
ETHYL ACETATE
DIACETONE ALCOHOL
MERSOL (SOLVENT ALCOHOL)
COTTON SOLUTIONS
SOLVENTS· PLASTICIZERS AND RESINS
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Most of the above uses of urea are practically trouble proof, but care in design and cure of the pieces should be taken in the molding of any heavy section, balls and knobs, pieces with large inserts and parts frequently exposed out of doors, to frequent handling, or washing. It is generally conceded that molding from urea compound of sections thicker than one-quarter inch, or parts to be sterilized by boiling, or to come in continuous contact with water, should be avoided. In designing the piece, it should be remembered that fillets and rounded corners are essential, although they can be of very small radii. Undercuts must generally be avoided, curvatures and tapered surfaces being preferable.

Urea compounds are supplied to the molder in either fine powder or granular form, and the latter is usually "pilled" or briquetted to facilitate handling. The material is then placed in highly polished steel dies heated to 280-320 deg. F., and subjected to pressure of from one to five tons per square inch of projected area of the piece. The heat first causes the material to soften into a plastic mass. For perhaps 20 seconds the mass flows into every space allowed, forming the piece, which then sets into a hard, infusible form. In molding certain types of pieces, it is necessary to "breathe" the mold, i.e., allow the gas formed in the softening process to escape. Recent developments have made this procedure unnecessary in the majority of cases. The piece is left in the mold, or "cured," from thirty seconds, in the fabrication of small objects such as buttons, to as long as twelve minutes, in molding large, thick castings such as radio cases. Generally speaking, the dimensions of the molding determine the length of cure, but where it is to be exposed, for instance, to water, or outdoors, a thorough cure is always necessary.

Sometimes, apparently perfect castings are removed from the mold before completely cured, but these will deteriorate upon the slightest exposure to moisture. To prevent this undercure, test moldings are often boiled for from five to fifteen minutes, and no chalking or whiteness of the surface should result if the cure is complete. Where the optimum cure is necessary, pieces may be tested by boiling in water for fifteen minutes, then immersing them in cold water for five minutes. The gain in weight should not be more than .030 gms. per sq. in. if the pieces are thoroughly cured and may be as low as .020 gms. per sq. in. Overcure, or burning, is at once apparent because of perceptible discoloration.

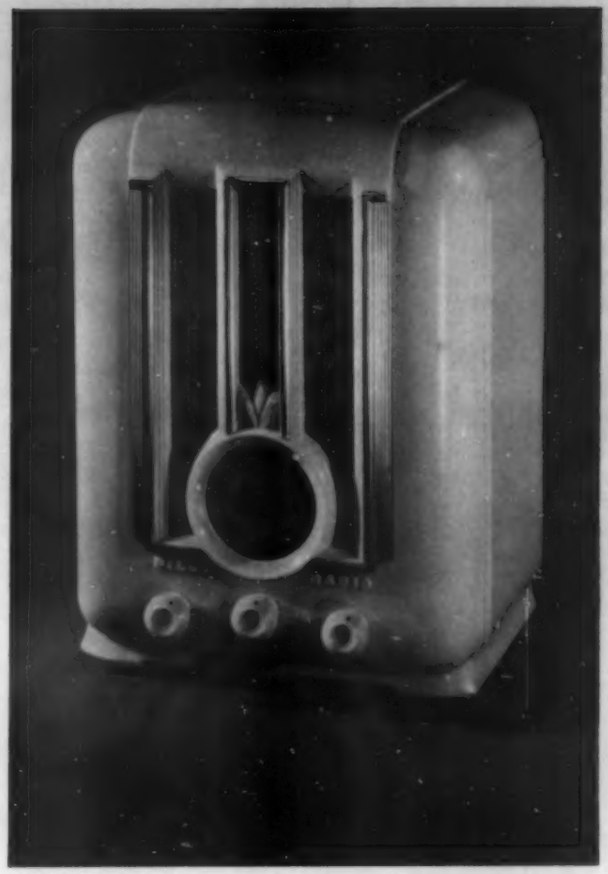
In molding ureas,[2] as with all light colored plastics, the utmost precaution must be observed in keeping the material clean. If possible, the presses should be in rooms apart from those in which phenolics are molded, but when this is impossible, the presses are usually shrouded with dust proof cloth. Compressed air is employed to blow any foreign matter from the molds, and the material itself is covered, because a single speck of dirt will cause a casting to be rejected.

Ureas mold as readily and easily as phenolics, but the standard of fabrication is higher because the pieces almost invariably go into fields where appearance is of paramount importance. Internal defects and specks of foreign matter do not spoil the appearance of phenolic moldings, but may cause the rejection of a light colored, translucent urea piece. However, castings satisfactory in every respect are produced by modern molding methods, in the best shops throughout the country. Urea moldings are finished, or polished when required, by the same standard methods used on other thermosetting materials.

[2] See article "Color molding and its requirements" page 220.

PLASKON

The Waltham watch now comes packaged in this attractive box of white plastic with contrasting cover in blue



PLASKON

Many radios take advantage of the polished surface of urea plastics for their cabinets

BEETLE

The I. E. S. tag of approval has been awarded recently to urea reflectors on student lamps

Finished pieces are chip-, rust- and corrosion-proof, and possessed of a smooth surface and high luster. They may be tapped, drilled or subjected to any common machining process, but machining of the surface should usually be avoided, due to the possibility of checking after long periods of use. A machined surface can, however, be highly polished. Lettering or fancy designs may be impressed into the surface of moldings, and if desired, the depressions may be wiped in with colored lacquers. Conversely, lettering may be raised on the surface when desired, by means of a slight alteration on the molds.

An immediate shrinkage of from .004 to .008 in. per in. takes place in the castings soon after being removed from the mold, followed by a further shrinkage up to a maximum of .011 in. per in. from mold dimensions. By careful, controlled fabrication castings may be held to a tolerance of plus or minus .002, but it is advisable not to specify tolerances as narrow as this, because of seasonal variation, which has been observed to be as high as .002 in. per inch.

Urea moldings will withstand about 170 deg. F. continuously, and as high as 245 deg. F. for short periods of time. At temperatures higher than these discoloration and opacification are apt to take place. Inserts are frequently molded into urea pieces, without harmful results. Large flat inserts up to 1½ in. in diameter have successfully been used, and thick, heavy slugs molded into place. The molded piece will give enough upon expansion and contraction of the metal to compensate for the difference in the coefficients. The insert should not, however, form any considerable part of the molded piece.

As with the use of all types of plastic compounds, pieces which are to be molded from ureas should be carefully designed and studied before the molds are built. Dies are expensive and while they can sometimes be rebuilt if engineering errors are discovered, this is a costly process and one which is not accomplished in a day.

Urea resins or syrups have a use in the decorative laminating field as a material to be used for coatings for light colors. Here again the hard, resistant, durable surface provides not only decoration, but it is easily washed, impervious to insects, and certain chemicals, and withstands indefinitely, wear and tear. Because of the clarity of the resins and their adaptability to color, steps have been taken toward the development of translucent laminated panels, for indirect or trough illumination. Not only has the resin entered this field, but it is rapidly finding a use in the treatment of textiles and as a cement to be used with molded items.

Cast resins—

(*Continued from page 27*) in working cast phenolics to deliver the fabricated items required ready for use.

Cast phenolics owe their popularity quite largely to their beauty and decorative value, but their widening use depends also on ease of fabrication and excellence in properties other than those appealing to the eye. Being non-inflammable, no fire hazard is involved in fabrication, storage or use. Because of the smooth finish and low heat conduction of the material, it has a pleasant feeling and is not cold to the touch as is metal. Since coloring is not superficial but penetrates through the material, it cannot wear or chip off. As a dielectric, the material is excellent. It is quite resistant to moisture and is not injured by ordinary washing, but is not recommended for use in continuous contact with moisture.

For practical purposes, cast phenolics are "fully" cured when delivered to fabricators, but a slow polymerization and consequent slight shrinkage continues under normal exposures for some months. In most applications, this is of no significance; in others due allowance can be made. Hardness increases somewhat with aging. For special purposes, particularly scientific instruments and the like, cast resins which have no shrinkage and are practically inert are available.

Plastics which harden permanently when cured and are not softened again by the application of heat are called thermosetting plastics and cast phenolics are usually so classified. But since the cure is not strictly complete in the form in which they are commonly delivered, they can be softened temporarily by heating to a temperature of around 200 deg. F. and for certain purposes are so heated in fabrication work. This is done when rod stock is to be sliced in cleaving machines and when pressing some forms of button blanks, as well as when stamping from thin sheet. Although such heating softens the material temporarily, it hardens quickly upon cooling, and when cool is as fully cured as before. Too long a heating or heating at excessive temperature tends to increase hardness and sometimes to darken the color and, therefore, should be avoided. Such heating as normally occurs in use, as in washing or in using kitchen implements around a stove, has little or no adverse effect on handles of cast phenolic materials unless they are exposed to open flame or to so hot a fire as to cause surface discoloration and blistering. Millions of such handles are used for cutlery, tableware and other purposes about the household.

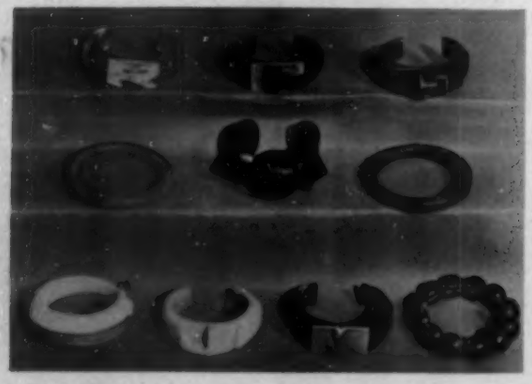
Besides the more or less conventional uses of cast phenolics, new uses are being found and extensions of the older uses along new lines are being made. Some of these, such as the casting in a special form of shallow molds in somewhat intricate designs which can be undercut, are still in the development stage and have great promise, especially since hardened steel forms are not required and the inexpensive molds can be used repeatedly for making the same castings either singly or in multiple. It has also proved possible to cast rods up to five feet in length in a special form of mold filled in a novel way and yielding a finish which does not require polishing, but this has only limited applications as yet.

A characteristic of the cast types of phenolic resin is their light (substantially water-white) color. The clear crystal is somewhat more water absorbent than other types, but this is of no significance for most uses, which are largely decorative. The casting resins, while still in the liquid state, can be employed also for laminating and if the material impregnated before laminating is white and translucent, a white or very light-colored translucent sheet is the result. Urea resins are employed in making light-colored laminated stock, but superior results are now claimed with light-colored phenolic resins. The resulting material is not only attractive in translucency and color but can be turned out in thin and rather flexible forms which promise a widening market for the laminator. As yet, this type of stock has not found extensive application. It is still somewhat in the development stage, although considerable quantities are now being consumed.

Such are some of the newer developments in cast phenolics. It will be seen that this form of plastic is opening new horizons. Its markets are far from remaining quiescent. It would be rash to predict how far it may go, but it can be said that developments are in many progressive hands and that cast phenolics seem destined to earn a still more important place among the modern synthetic plastics.

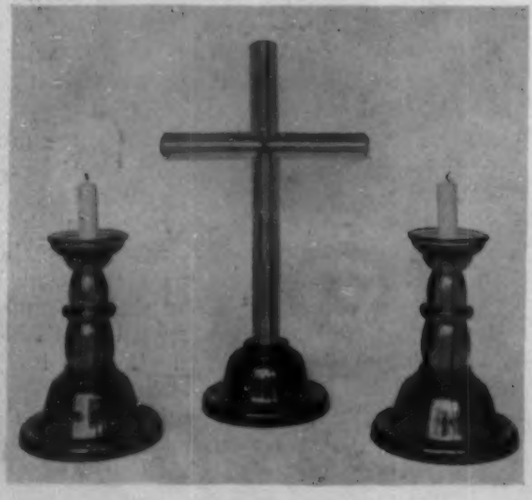
4. A few recent designs of cast resin bracelets developed in Paris. 5. Religious emblems are frequently made from these easily turned and shaped materials

4



CATALIN

5



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Shellac, the original thermoplastic

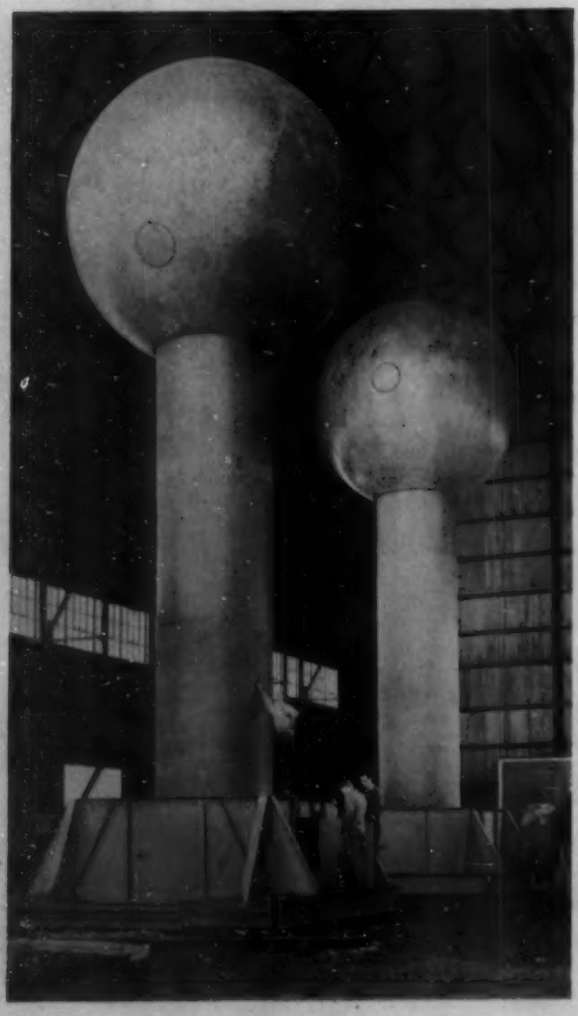
(Continued from page 49) tions have to be exercised.

Compounding

Compounding ingredients are selected depending on the purposes for which the composition is to be used. They may roughly be divided into (1) inorganic fillers including pigments, for bulk, cheapness, and color; (2) fibrous materials for strength, and (3) other resins, waxes or modifying agents. The total resin content generally runs from about 20 to 50 per cent, the fibrous material from about 3 to 10 per cent, and the balance inorganic fillers. Special care must be exercised in the selection of coloring materials on account of the acid nature of the resin.

Shellac compounding is carried out on mixing rolls which are steam heated, or in an internal mixer such as the Banbury. The latter gives excellent results since the mixing is accomplished through a smearing action and complete wetting of the fillers is accomplished in a remarkably short space of time. With less surface exposed to the air, there is less tendency for the shellac to burn out and much better control is obtained.

Electrostatic generator, built by the Massachusetts Institute of Technology. The towers are hollow cylinders of paper bonded with shellac which proved to be the only material possible to use for the purpose. Spheres at top are of the same material



Molded products

The molded product par excellence is the phonograph record. The tiny groove, a few thousandths of an inch in width and requiring a good magnifying glass to be seen clearly must carry the crashing climax of a huge orchestra or the delicacy of a love song. Exactness to a hundred thousandth of an inch is necessary for pure tone production. No roughnesses are permitted in the surface to develop harsh and unpleasant noises. Every record must be perfect. Yet the surface must be hard and tough. It has been estimated that the point of a phonograph needle exerts a pressure of between 50,000 and 80,000 pounds per square inch on the surface. Moreover, a record must stand up under hundreds of playings.

Shellac possesses the qualities required. Easy moldability, re-use of scrap and seconds, strength, hardness, low cost, and absolute reliability—these are the qualities which made possible the creation of an industry running into hundreds of millions of dollars annually. While the phonograph has been supplemented or replaced by a radio set in many homes in this country, it may be noted that much broadcasting today is from records and that in other parts of the world phonographs are still popular. As a matter of fact, phonograph record consumption is actually increasing at the present time in this country. This is in a large part due to the popularity of the automatic reproducing machines to be found in so many public drinking places. It is estimated that phonograph records take 30 to 40 per cent of the annual lac output, although they are made from acetates and vinyl resins as well.

In addition to shellac's fine molding, flowing and extruding properties, it is an excellent insulating resin, and furthermore, is practically oil-proof. Shellac moldings are being regularly used, immersed in all kinds of oil.

Electrically, shellac is one of the hardest resins for an electric current to arc or to track over. Shellac insulators that have been short-circuited almost always remain good insulators, since the current leaves no track on them. In addition, shellac's dielectric properties are unique—one striking example being its use as insulation in high voltage apparatus used for breaking down the atom. We believe one such application included voltages as high as ten million volts, and are told that practically no other material was found which would stand up. These unique electrical properties make shellac extremely valuable to manufacturers of electrical goods of all kinds. In some of the large electrical plants, shellac has as many as two hundred different applications.

In addition to molded goods of various types, similar uses for shellac are in the bonding of grinding wheels and mica products. In grinding wheels, abrasive grains are first coated with melted shellac; after cooling and grinding, the coated grain is placed in molds and subjected to heat and pressure, after which the wheel is finally cured in ovens at controlled temperatures. In mica plate manufacture, the application is usually with a solution of shellac in alcohol, with which mica sheets are coated and the alcohol is driven off by heat before the bond is made. In both cases,

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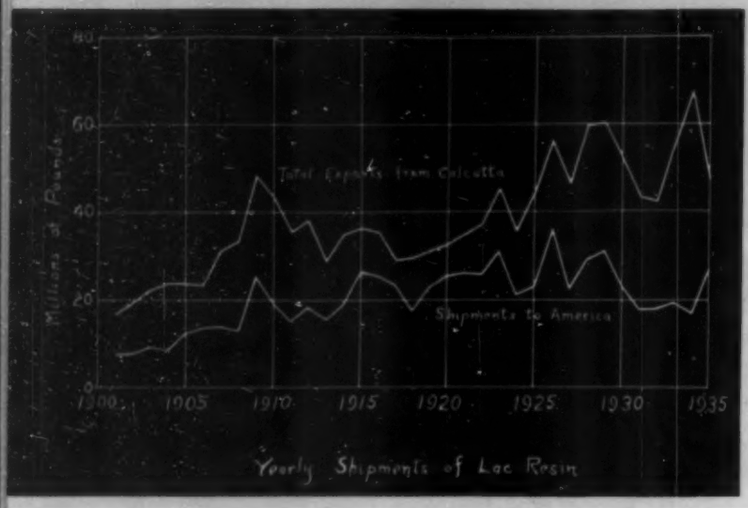

FIG. 1. Total annual exports of lac from India and corresponding shipments to America from 1901 to 1936

however, the bond is a surface bond, there being no penetration of the substance bonded by the bonding material. Shellac in grinding wheels has in a small degree been replaced by phenolic resins in those applications where the requirement is for a harder wheel, but wherever high finishes are required and in all other applications where shellac has long been used, it is still on the job and we believe will never be replaced. In mica work, it is not only valued for its unique bonding and flowing, but principally for its remarkable dielectric properties.

Another use in which the unique properties of shellac are employed is in the manufacture of dental base plates. Here the plate is first formed by hot mixing with various fillers and the molten mass rolled into sheets which are then stamped or blanked out. In actual use, the plate is re-heated, the impression taken and the plate on cooling retains the form and acts as a mold. Other more familiar applications of shellac as a plastic are in the manufacture of poker chips, billiard balls, counters, buttons and similar articles.

Thermosetting properties

The relatively low softening point of shellac when compared with thermosetting compounds is a handicap in certain applications. Consequently, attempts have been made to increase the temperature at which shellac compounds will soften. Certain organic and inorganic compounds when added to shellac, increase the rate of polymerization or change to the non-fluid state. In some cases at least, these compounds merely speed up the elimination of water. In other cases, the action is not entirely clear. Acids and acid liberating substances are generally powerful accelerators. Some nitrogen containing compounds such as hexamethylenetetramine, urea, benzidine or ammonium salts also act as accelerators. Shellac can likewise be modified by the introduction of heavy metal oxides or sulphur.

Shellac compositions polymerized as above have been made which stand temperatures up to about 550 deg. F. without appreciable warping and which can be drawn hot from the mold. These compounds have not yet been adopted in industry to any extent but they offer possibilities which would appear most attractive from a commercial standpoint.

Consumption

In Fig. 1 are shown the total annual exports of lac from India and the corresponding shipments to America for the years 1901 to date. These curves show a fairly regular increase up to 1909. While statistics of the separate industries are not available, undoubtedly the plastic and electrical industries were using increasing quantities of shellac during this period. From 1909 to 1913 a decline occurred. War demands stimulated the export of shellac from 1914 to 1916, although during the last two years of the war, 1917 and 1918, and in 1919, the diversion of shipping to other purposes interfered with shipments somewhat.

In 1921, the British Government realizing the value of their natural monopoly in India and the threat of synthetic resins, established the Indian Lac Research Institute to assist in the development and use of lac products. It was 1925 before active research was started in India, but this has been followed by the establishment of two research laboratories in England and, comparatively recently, they have cooperated with the United States Shellac Importers Association in support of the Shellac Research Bureau in this country.

From 1920 to 1929, during the boom years, the increase was somewhat erratic though plainly marked. The effect of the world depression is evident from 1929 to 1932. In 1933, recovery started, due partly to the activities of a speculative pool in London, which unsuccessfully tried to corner the shellac market. This pool collapsed in 1935 and fortunately, at the present time, its excess holdings have been liquidated—to a considerable extent through shipments to this country. This is shown by the sharp rise in the American shipments and a corresponding drop in shipments out of Calcutta.

The curve of shipments to America in general follows the curve of total shipments from India closely. The increase in total consumption up to 1926 came largely from this country. After that year, other countries began to take a greater part of the world supply, while demand from this country fell off due to the decline of the phonograph industry and the depression. It was only with the year 1935 that the curve shows a sharp turn upward again—a demand which has continued into this year. With the liquidation of the London pool, it is believed that the market can again look forward to a normal expansion with fairly steady and reasonable prices.

It should be noted that the normal trend of the shellac industry has been upward and that the average world consumption has approximately tripled in the last thirty-five years. This increase is small as compared with the growth of the synthetic resin industry but it shows a healthy development in the application of a natural product which is finding new uses even though it was known and used prior to the Christian era.

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All **FLOCKS** may be used to increase the mechanical strength of regular compounds. They give compounds with mechanical strength between those obtained with wood flour and fabric filled materials. Longer fibered **FLOCKS** give compounds nearly as strong as some of the fabric filled. At the same time the molded parts have a much better surface appearance. Fabric filled materials all show particles of cloth in the surface of the finished piece and therefore cannot be used where a good looking piece is desired. Due to the length of the fiber, coverage of the **FLOCKS** with resin and dye is somewhat more difficult than with wood flour but can be accomplished by using a soft resin, which becomes quite fluid while being compounded under heat.

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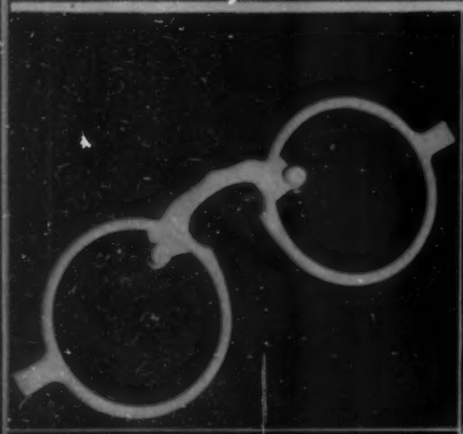

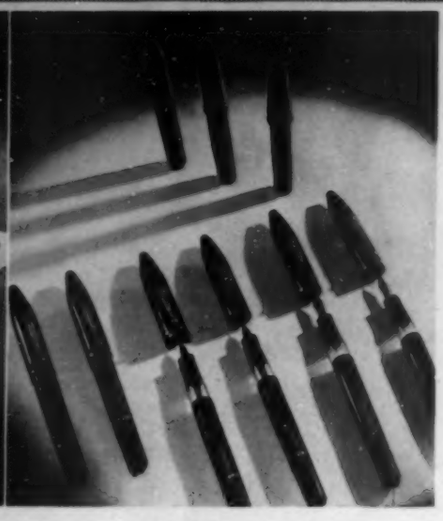

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- Easy moldability
- Superiority in the molded article through:
  - Toughness
  - Resiliency
  - Cold flow factor
- Low shrinkage in the mold
- Minimum shrinkage after molding
- Unlimited color range

Through these outstanding features of the *new* and *improved* Lumarith molding materials molders have been given opportunities to explore new fields, increase applications of molded parts, and at the same time offer molded pieces to the ultimate users, which for their colorfulness, beautiful appearance in finish and feel and toughness in use are unexcelled. Lumarith's increasing applications attest to its excellence by the wide acceptance given to it by molders. The unique experiences of Celluloid Corporation engineers in the field of thermoplastic molding, backed by the complete research facilities of its famous laboratories is a welcome aid to molders or to the prospective users of molded parts.

Send for this free handbook . . . packed with detailed information about Lumarith Molding materials and methods.

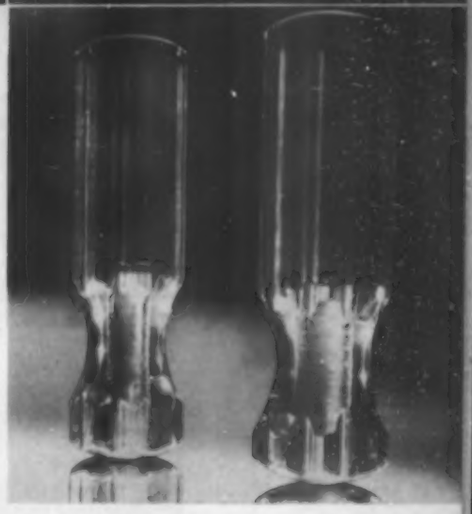
CELLULOID CORPORATION

THE MOST VERSATILE OF ALL THE PLASTICS

A PRODUCT OF CELLULOID CORPORATION

LUMARITH IN OTHER FORMS—

such as *sheets*, *rods*, *tubes*, *rolls* (continuous lengths) presents a complete range of raw materials with which the fabricator can make either the colorful, dainty flowers illustrated here or the sturdy, amber colored tool handles.



Lumarith meets varying requirements with:

- Color—From the most subdued pastel shades or the deep opaque colors to the most brilliant with all kinds of mottled and variegated effects.
- Versatility—An easily worked plastic material which can be carved, cemented to itself or other materials, color dipped, die-formed, embossed, laminated, machined, molded, pleated, printed, scored, stitched, stretched, swaged or even handshaped.
- Strength—A strong, tough and yet resilient material.

No matter how varied your requirements the chances are that Lumarith can help make your product a better one, a more beautiful and more salable one. Write, wire or phone

10 EAST 40TH STREET, NEW YORK CITY

Pyroxylin (cellulose nitrate) plastics

(Continued from page 25)

Workability

In the fabrication of many articles the material, because of its thermoplastic character is molded to final shape in heated molds under pressure, with subsequent chilling to set the material. Temperatures up to 250° F. may be used, with pressures ranging up to about 2000 lbs. per square inch. In the manufacture of hollow articles fluid pressure is applied internally and the material blown or expanded to the shape of the retaining mold. Other articles are more economically fashioned by mechanical operations such as blanking, sawing, milling, routing, drilling, tapping, turning and such other operations as may apply to wood or similar materials. In operations creating a high degree of frictional heat the material should be chilled with a stream of water to prevent combustion of the stock.

Pyroxylin plastic may be heated and stretched within the elastic limit of the material, and then set by cooling so as to retain stresses in the material which, when released by reheating, return the material to its original form. This principle is utilized in the veneering of such objects as golf shafts, towel bars, strap hangers, etc. A tube of the plastic is heated in boiling water and while hot stretched over a metal mandrel. It is then plunged into cold water to set the material. The stretched tube is removed from the mandrel, placed over the article to be veneered and shrunk tightly on the piece by reheating in hot water or in an air oven.

Cements

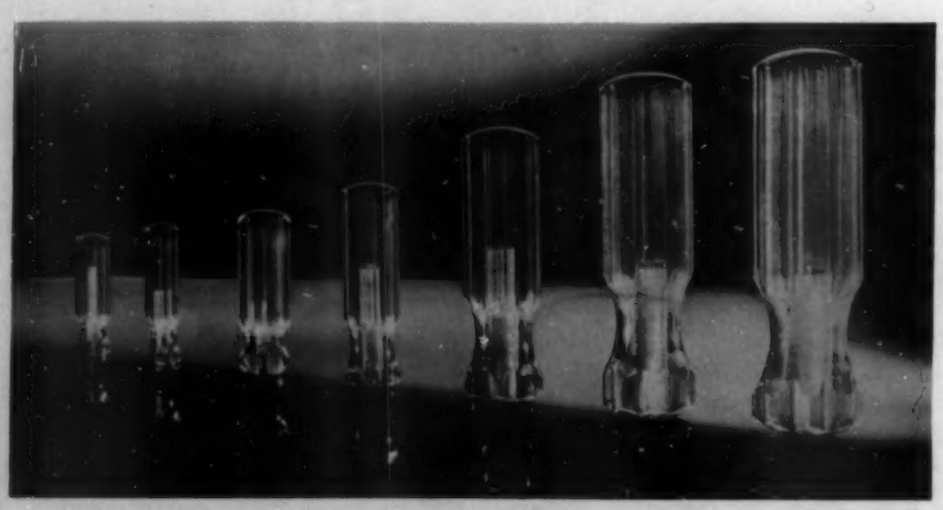
Certain solvents have the property of softening pyroxylin plastics without dissolving them so as to render them tough and very pliable. For example, wooden heels and wooden toilet seats are veneered by softening sheets of pyroxylin plastics in a mixture of 80% wood alcohol and 20% water until soft, and then stretching over the wood forms, and allowing the sheet to dry and shrink tightly on the form.

Pyroxylin plastics are readily cemented to themselves by the use of such solvents as acetone, ethyl acetate, butyl acetate, etc., and to many other materials by the use of body cements containing cellulose nitrate, plasticizers and solvents. This property is of great advantage in simplifying the fabrication and assembly of many articles.

As a further decorative feature the beauty of the material may be enhanced by a highly polished surface produced mechanically by buffing wheels and suitable abrasives, or the surface may be printed, embossed by heated dies, or engraved. Because of the very wide and divergent uses of pyroxylin plastics it is obvious that its physical and chemical properties are not all definitely fixed but may be varied at the will of the manufacturers to meet particular requirements. This makes desirable a close cooperation between manufacturer and fabricator with an understanding of their mutual problems so that the most suitable material may be supplied for a particular use.

Pyroxylin plastics are practically unaffected by hydrocarbons and chlorinated hydrocarbons, animal, vegetable and mineral oils and low concentrations of mineral acids at normal temperatures. They are attacked by organic acids such as acetic and formic acids at normal temperatures and by mineral acids at elevated temperatures and high concentrations. They are decomposed by alkalies in any appreciable concentration and are dissolved or softened by many alcohols, ketones and esters. They will absorb water with a very slight change in volume up to about 1.5 to 3.0% of its weight with slight softening and increased plasticity.

Pyroxylin plastics are extensively used today, but many of the manufacturers of these products are now also engaged in the manufacture of cellulose acetate plastics. It is often predicted that the eventual use of the cellulose acetate plastics will surpass the volume of pyroxylin plastics, replacing it in many ways.



One of the most practical industrial uses of pyroxylin is in the manufacture of screw driver handles in which it serves as splendid insulation as well as a safe and easy grip

Are *you* getting *your* share of this New Plastic Business?

Oilproof synthetic rubber plastic important entry to field.

The development of "Thiokol" synthetic rubber plastics placed every molder of ureas and phenolics in the position of being able to supply many types of rubber-like, resilient goods. Without the addition of a single piece of molding equipment, molding concerns are furnishing such "Thiokol" products as bolster pads for stamping presses, soap dishes, diaphragms, seals, packing rings, gaskets and washers.

Two great reasons for the acceptance and the undoubtedly wider application of "Thiokol" molded products in the future are these: (1) a large variety of molded rubber goods can be produced more economically using the conventional plastic molding process than can be produced by rubber processors. (2) "Thiokol" products are completely resistant to the effects of almost every solvent; natural rubber products are not. Natural rubber goods coming in contact with solvents, deteriorate rapidly, lose resiliency and necessitate frequent replacements. A "Thiokol" product will wear out before the effect of solvents impairs it. Furthermore, certain "Thiokol" products possess advantageous electrical properties, i.e. low power factor, dielectric strength and dielectric constant.

"Thiokol" synthetic plastics are furnished in the form of vulcanized and compounded molding powders which require only heat and pressure for forming into unbreakable molded articles. There is a "Thiokol" powder for molding products of varying hardnesses ranging from a very soft to an extremely hard type. During the molding, which is merely a forming operation, each powder flows and knits together perfectly.

If you have not already investigated "Thiokol" molding compounds you should do so now. Write today for complete technical information.

◆

NOTE TO PRODUCT MANUFACTURERS:

"Thiokol" oilproof synthetic rubber products are constantly replacing metal, leather, cork and natural rubber for a host of machine, appliance and unit products. For your new and redesigned products, you can rely upon "Thiokol" to solve your problems where a material possessing elasticity, resiliency and resistance to organic solvents is needed. Let us show you what others have done in applying "Thiokol" to improve their products.

THIOKOL Corporation

THIOKOL

YARDVILLE NEW JERSEY

Synthetic rubber lined discharge hose used to unload fuel oil, benzol and other solvents is not affected by them

An unloading operation which employs a Thiokol rubber hose to unload cargoes of fuel oil and toluol from tank steamers

(*Continued from page 46*) the same extent as rubber by many other solvents such as benzene, toluene and the chlorinated solvents. Compounds of both types of synthetic rubber examined by the writer have shown them to be somewhat superior to equivalent compounds of natural rubber on exposure to elevated temperatures (around 100 deg. C.) but definitely inferior in ability to withstand low temperatures without cracking on flexure.

It is very improbable that either the butadiene or the chlorobutadiene polymers can ever even closely approach the price at which natural rubber can be profitably sold, as their manufacture involves highly complicated and sometimes hazardous processes. The exact degree of polymerization is difficult to control, the plant equipment is expensive and depreciation high.

The first commercially successful synthetic rubber to appear on the American market was an ethylene polysulfide polymer[3] designated by the letter "A." This product had many shortcomings. It had a penetrating unpleasant odor, it was not nearly as good as natural rubber at high temperatures nor was it suitable for use at temperatures below zero Fahrenheit, and its physical tests were not high, tensiles of around 900 lbs. per square inch were about the maximum obtainable. But it was definitely a synthetic rubber, looked and felt like rubber, it had absolutely unique resistance to all classes of solvents and it was cheap. Furthermore, it was completely unaffected by sunlight even on several years' exposure, and would withstand ozone without cracking or crazing, and its water absorption was only a very small fraction of that of the best rubber compound.

The immediate acceptance of this material and the steady increase in the tonnage required proved that there was a very definite need for a solvent proof synthetic rubber. In its own field it is performing a service that no other rubber, natural or synthetic, had ever rendered.

As the chemistry of the polysulfide rubbers is such that it permits of a very large number of possible combinations, each of which produces a rubber having different properties, a second olefin polysulfide derivative was put on the market and given the designation "B." This "B" material possessed about the same physical properties as "A," but was free from objectionable odor and withstood flexure at low temperatures better.

The requirement for a synthetic rubber for fuel oil and gasoline hose in which good tensile strength and abrasion resistance, together with complete resistance to oil and gasoline must be included with complete flexibility at temperatures of 35 to 40 degrees below zero, led to the development of a third variety of synthetic rubber. This material, designated as "D," fulfilled all these requirements.

The chemistry of the polysulfide rubbers is fundamentally simple, involving as it does, condensation between hydrocarbon dihalides (or in some cases polyhalides) and polysulfide solutions. When hydrocarbon dihalides having, for example, CH_2Cl terminal groups, are caused to react with, say, sodium polysulfide solution, a linear polymer of high molecular weight is usually obtained. Many such polymers display uniquely rubber-like characteristics even to the development of the X-ray fiber diagram on stretch, they also exhibit the *Joule effect*.

A few examples of the type of reaction are as follows:

$$Cl\,CH_2Cl + Na_2Sx \rightarrow -CH_2SxCH_2SxCH_2Sx-$$
$$Cl\,(CH_2)_2Cl \quad " \rightarrow -(CH_2)_2Sx(CH_2)_2Sx(CH_2)_2Sx-$$
$$Cl\,(CH_2)_5Cl \quad " \rightarrow -(CH_2)_5Sx(CH_2)_5Sx(CH_2)_5Sx-$$
$$Cl\,C_2H_4OC_2H_4Cl \quad " \rightarrow -C_2H_4OC_2H_4SxC_2H_4OC_2H_4Sx-$$
$$Cl\,C_2H_4OC_2H_4OC_2H_4Cl \quad " \rightarrow -C_2H_4OC_2H_4OC_2H_4Sx-$$

If, for example, the polysulfide used is a properly prepared solution of sodium tetrasulfide, Na_2S_4, it will react very readily with its equivalent weight of symmetrical dichloroethane to form the polysulfide rubber, and if the reaction is carried out in the presence of a suitable dispersing agent, a latex will result which, when washed free from water-soluble impurities, will coagulate with dilute acid to a white rubbery

3. Thiokol.

mass in a manner very similar to a natural rubber latex.

Another peculiar analogy with rubber is noted when the soft plastic powder is milled with zinc oxide and heated. At temperatures ordinarily used in the vulcanization of rubber, cure takes place and the plastic mass becomes firm and strongly elastic, this effect being enhanced if carbon black is also a constituent of the mix.

Very remarkable variations in the physical properties of the derived rubbers are obtained when the character of the hydrocarbon bases are altered. For example, it became obvious that a really satisfactory gasoline hose should not only be totally unattacked by any of the various blends of gasoline on the market, some of which may contain considerable proportions of benzol, but should remain flexible and elastic at temperatures as low as 35 degrees below zero.

It was found that by a shift in the hydrocarbon base this specification could be completely met and a commercial rubber was developed, the "D" material, which when properly compounded and cured was so impervious to the action of gasoline that it neither swelled nor imparted a trace of color to the solvent when immersed in gasoline over a period of months, and was perfectly flexible when submerged for hours and flexed in a gasoline bath cooled to 35-38 degrees below zero Fahrenheit. By a further extension of the theory a rubber, which is not yet in commercial production, was produced which remained flexible and elastic when tested at 60 degrees below zero Fahrenheit.

A development which has made feasible a radical change in accepted rubber practice was made possible by the wide scope of the chemistry of the polysulfide rubbers. A type of synthetic rubber was produced which could be compounded to any suitable degree, depending upon the use to which it was to be put, and finally cured in any quantity desired in an open steam vulcanizer. The vulcanizate was then reduced to a fairly fine powder in a special type of mill. This powdered material can be molded into the most intricate forms taking on an average only three minutes at temperatures around 300 deg. F. to a heat. Gaskets, packing materials, sheets, cups and printing plates of live resilient rubber, which is not swollen by oils nor subject to oxidation are produced in this way at only a fraction of the cost of processing and curing natural rubber. The hardness of the finished products made from these rubber molding powders can be varied all the way from about 50 Shore hardness to that of vulcanite.

This oil proof synthetic rubber is now being used in practically all industries in applications where other rubbers are unsuitable on account of exposure to oils and other solvents, low temperatures, effects of sunlight, oxidation, etc. When the simplicity of the manufacturing process and the moderate investment required is considered, together with the potentially low cost and ready availability of the raw materials, it becomes apparent that the polysulfide rubbers can eventually compete in cost with the price at which natural rubber can be economically sold.

Phenoform

Colors

A wide range of colors for plastic compounds — especially selected and prepared to meet the most exacting requirements in molding. For particulars apply to

General Dyestuff Corporation

230 Fifth Avenue, New York, N. Y.

Cellulose acetate plastics

(Continued from page 23)

TENNESSEE EASTMAN

5

6

5. Automobile hardware makes practical use of acetate material which is molded over a metal core and may be colored to match interiors or contrast harmoniously. 6. Many novelties are made from the same material including jewelry and boutonnières

acetate has greatly increased, due to more detailed attention to the problem of quick and uniform heating and cooling of molds. At the present time multiple cavity molds for relatively flat thin articles have cycles as short as 2½ minutes, while some of those having cavities with some depth take only 3½ minutes—less time in some instances than that required for the thermosetting reaction in an article of equal size.

As a development of the future in rapid heating and cooling, molds made from beryllium copper, with the high heat conductivity of that metal, have reduced the cycle to approximately one-sixth of the time which would be required for forming the same article in an ordinary steel mold. Other manufacturing advantages include the cementability of acetate to itself, to provide a bond almost equally as strong as the molded piece itself.

The commercially new development of injection molding has opened an immense field to thermoplastics. Acetate is particularly adaptable to this method of operation which is in principle not unlike the die casting of metal. Instead of heating and cooling a mass of metal the material in plastic form is "squirted" into a mold which remains constantly chilled by the circulation of water. Cycles of up to six "shots" per minute are obtained.

Injection molding eliminates any sizable fins to be removed in finishing, and permits 100% utility of the material. This method also permits covering metal inserts in such items as door knobs, gear shift balls, automobile interior hardware, and plumbing hardware, where the rigidity of metal in the core is combined with the beauty and toughness of acetate as a covering. In such applications three cycles per minute, which includes positioning of inserts, are attained in multiple cavity molds. In injection covered articles the core can be rough; there is no necessity for the finish required preparatory to electro-plating a similar piece. Aside from the speed of the operation which injection molding affords, it permits the molding of articles which would be impossible by the conventional compression method. Injection molding again has its limitations; pressure required is five to ten times greater than in compression molding of plastics or in die casting metal.

Acetate is the logical molding material when lustrous finish, great strength in resistance to impact, and beauty through depth of color is required. Striated effects of mixed colors procurable by the compression molding of blanks or the injection molding of granulation offer configurations which cannot fail to be attractive to the designer as well as the purchaser. The possibility of "custom made" colors to harmonize with draperies, upholstery, household and automobile hardware, makes an acetate molding material unique.

The insistent demand for pastel shades by decorators and the consumers can be quickly met by molders who are equipped to efficiently handle these materials.

Phenolic molding materials

(*Continued from page 19*)

Power Factor at 1000 Cycles 0.13.
Power Factor at 1,000,000 Cycles 0.05.
Volume Resistivity 1.7 x 10^5 megohm cms.
Dielectric Constant at 60 Cycles 10.
Dielectric Constant at 1000 Cycles 7.
Dielectric Constant at 1,000,000 Cycles 6.

B. *Magneto insulation.* This type of material is for use on aircraft and other ignition parts where an extremely high insulation resistance is desired. Further, this material has the ability to withstand high voltage low amperage arcs such as those encountered on magnetos. The following table of properties is representative of this class of materials:

Physical (Molded):
Specific Gravity 1.34, Weight per cu. in. 21.9 gms.
Tensile Strength 5000 lbs. per sq. in.
Modulus of Elasticity 5.0 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.16.
Impact Strength—Per Inch of Notch ft. lbs. 0.32.
Impact Strength—Lbs. Per Inch Square 2.0.
Molding Shrinkage .006–.009 in. per in.
Flexural Strength 5000 lbs. per sq. in.
Distortion Under Heat 158°F (70°C).
Water Absorption Gain 2.0%.

Electrical (Molded):
Dielectric Strength at 60 Cycles 450 Volts per Mil. (inst.).
Dielectric Strength at 60 Cycles 390 Volts per Mil. (step).
Power Factor at 60 Cycles 0.05.
Power Factor at 1000 Cycles 0.04.
Power Factor at 1,000,000 Cycles 0.04.
Volume Resistivity 10.0 x 10^5 megohms cms.
Dielectric Constant at 60 Cycles 4.0–4.5.
Dielectric Constant at 1000 Cycles 4.0–4.5.
Dielectric Constant at 1,000,000 Cycles 4.0–4.5.

C. *Radio insulation.* With the increasing use of short wave radio receiving sets there was a need for materials of exceptionally low power factor. The following is a table of properties representative of this class of materials:

Physical (Molded):
Specific Gravity 1.90, Weight per cu. in. 31.3 gms.
Tensile Strength 6500 lbs. per sq. in.
Modulus of Elasticity 45 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.20.
Impact Strength—Per Inch of Notch ft. lbs. 0.40.
Impact Strength—Lbs. Per Inch Square 2.50.
Molding Shrinkage .0025 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Distortion Under Heat 257°F (125°C).
Water Absorption Gain 0.07%.

Electrical (Molded):
Dielectric Strength at 60 Cycles 475 Volts per Mil. (inst.).
Dielectric Strength at 60 Cycles 400 Volts per Mil. (step by step).

DU PONT

P.A.C. FORMALDEHYDE
U. S. P. Solution; Water White; Low in Acid; Low Metal Content

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95% Minimum Strength

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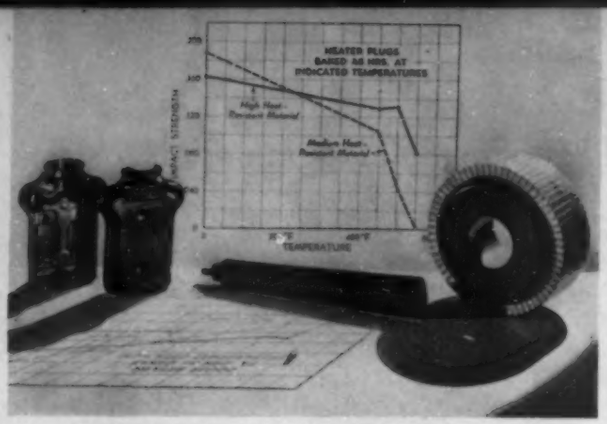
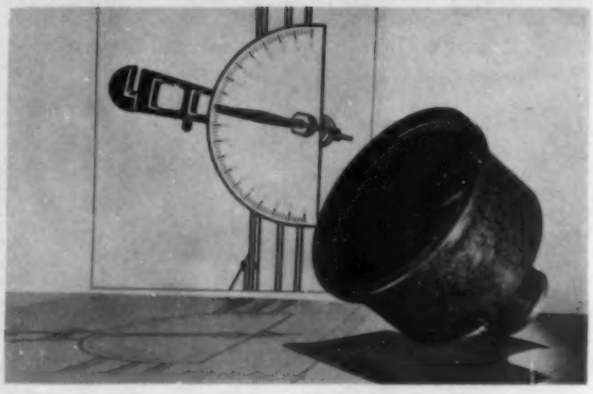
Phenolic molding materials

Power Factor at 60 Cycles 0.025.
Power Factor at 1000 Cycles 0.014.
Power Factor at 1,000,000 Cycles 0.007.
Volume Resistivity over 10^8 megohm cms.
Dielectric Constant at 60 Cycles 5.5.
Dielectric Constant at 1000 Cycles 5.0.
Dielectric Constant at 1,000,000 Cycles 5.0.

D. *Materials having high dielectric fatigue.* Recently there has been an increasing demand for these materials. No standard method of test has been approved to date, but it is sufficient to state that special products are available which—while on instantaneous or step dielectric tests in accordance with A.S.T.M. methods may be no better, or, in fact, sometimes inferior to other materials—have the ability to withstand over a period of time higher voltages than ordinary materials. These products at the present time are of particular interest in the production of automotive and aircraft ignition systems.

E. *Commutator materials.* This is a rather special use requiring a material of relatively high impact strength, high heat resistance, good tensile strength and low shrinkage. Experience has shown that the long fibred mineral-filled materials are of advantage. The following is a table of properties representative of this class of materials:





Above—High heat and medium heat resistant phenolic materials are available for special application. Below—Special phenolic molding with tensile strength of 8500 lbs. per square inch

Physical (Molded):

Specific Gravity 1.89, Weight per cu. in. 30.9 gms.
Tensile Strength 6000 lbs. per sq. in.
Modulus of Elasticity 10 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.50.
Impact Strength—Per Inch of Notch ft. lbs. 1.00.
Impact Strength—Lbs. Per Inch Square 6.20.
Molding Shrinkage 0.0035–.0085 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Distortion Under Heat 302°F (150°C).
Water Absorption Gain 0.08%. (Immersed as received for 48 hrs.).
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 400°F (204°C).

Electrical (Molded):

Dielectric Strength at 60 Cycles 200 Volts per Mil.
Volume Resistivity 0.2 x 10^5 megohm cms.

F. *Heat-resistant or heater plug materials.* The largest use of this class of materials is on connector plugs for electrical appliances, such as irons, waffle irons, toasters, and percolators. It is necessary to consider heat resistance from two points of view. First, the maximum temperature that a part will withstand without blistering. Second, the maximum temperature that a part will withstand without appreciable change in dimension or loss in mechanical strength.

Many assume that if a part will not blister when submitted to a given temperature for a period of hours, it is not affected in any other way. This is not the case. It is possible to produce a cellulose-filled material that will stand, say 450 deg. F. without blistering. However, after a relatively few hours at this temperature, the strength of the part is reduced to a point where it is practically useless. Hence, heat-resistant materials are manufactured by employing principally mineral fillers. Two types of heat-resistant materials are available, the properties of which are given in the following table: [1]

For medium heat resistance:

Physical (Molded):

Specific Gravity 1.78, Weight per cu. in. 29.2 gms.
Tensile Strength 6000 lbs. per sq. in.
Modulus of Elasticity 17.0 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.14.
Impact Strength—Per Inch of Notch ft. lbs. 0.28.
Impact Strength—Lbs. Per Inch Square 1.75.
Molding Shrinkage .0045–.0050 in. per in.
Flexural Strength 8200 lbs. per sq. in.
Distortion Under Heat 275°F (135°C).
Water Absorption Gain 0.18%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 400°F (204°C).

Electrical (Molded):

Dielectric Strength at 60 Cycles 300 Volts per Mil.
Volume Resistivity 0.2 x 10^5 megohm cms.

For high heat resistance:

Physical (Molded):

Specific Gravity 1.93, Weight per cu. in. 36.1 gms.
Tensile Strength 4900 lbs. per sq. in.

[1] Refers to Bakelite molded

Modulus of Elasticity 20 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.15.
Impact Strength—Per Inch of Notch ft. lbs. 0.30.
Impact Strength—Lbs Per Inch Square 3.88.
Molding Shrinkage .0035–.004 in. per in.
Flexural Strength 8000 lbs. per sq. in.
Distortion Under Heat 275°F (135°C).
Water Absorption Gain 0.046%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 450° F (232° C).

Electrical (Molded):

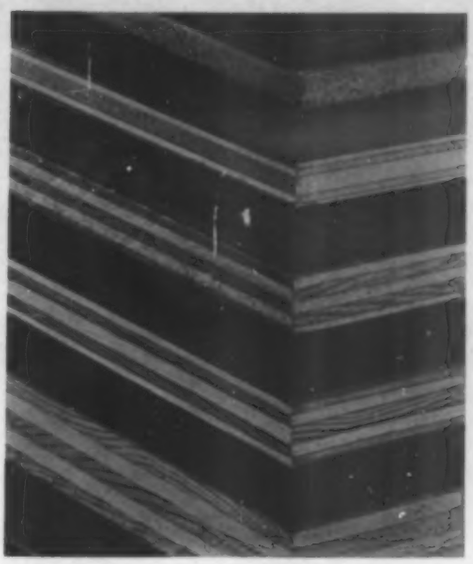
Dielectric Strength at 60 Cycles 250 Volts per Mil.
Volume Resistivity 0.2 x 10^5 megohm cms.

In these tables no comparison is given for these materials to disclose loss of strength when subjected to sustained temperatures. Experiments have shown that wall thicknesses of less than 1/8 in. lose strength much more rapidly than wall thicknesses of over 1/8 in., approaching 1/4 in. It has been found that impact strength or resistance to shock is a good measure to determine whether a product, when submitted to a temperature for a period of time, has been affected adversely in mechanical strength. Tests were recently made on a heater plug produced in both high heat-resistant and medium heat-resistant materials.

Nozzle and splash plate for cooling tower produced in chemical-resistant phenolic molding material

This plug had a wall section just under 1/8 in. After forty-eight hours at 450 deg. F. the high heat-resistant material had 79.2 per cent of its original impact strength. The medium heat-resistant material had 55.8 per cent. After forty-eight hours at 500 deg. F., the high heat-resistant material showed 84.6 per cent of the original strength, whereas the medium heat-resistant material showed 25 per cent. After forty-eight hours at 550 deg. F. the high heat-resistant material showed 58 per cent and the other was too weak to test successfully.

A still further comparison is interesting. A heater plug of approximately 1/4 in. wall section was tested, made of the high heat-resistant material only. After forty-eight hours at 450 deg. F. its impact strength was 321 per cent of the original. After forty-eight hours at 550 deg. F., 198 per cent of the original.



TEGO-BONDING

ANOTHER MILESTONE IN SYNTHETIC RESINS

THE application of phenol-formaldehyde resins to the production of waterproof, durable plywood has long been proposed. Bonding with Tego Glue Film represents its successful accomplishment.

Millions of square feet of Tego-bonded plywood have already been produced commercially. The practical problems of production have been overcome and the quality of the resultant product has set a new, established standard.

Tego Glue Film is manufactured by THE RESINOUS PRODUCTS AND CHEMICAL CO., Inc., Philadelphia, makers of Amberol, Duraplex, Paraplex, Aquaplex, Acryloid.

RESINOUS PRODUCTS

Above—Range timer of Durez. Below—Ignition coil case produced from a special electrical insulating Bakelite

It is our experience that unless specially treated, parts produced of the medium heat-resistant materials are apt to blister at temperatures above 390 deg. F. and parts produced of the high heat-resistant material will blister at temperatures above 410 deg. F. This condition can be remedied by baking molded parts at a temperature of 275 deg.-285 deg. F. for a period of seventy-two hours. It will materially increase the temperature at which blistering may occur. However, the temperature should not be raised to the point where mechanical strength loss takes place at too rapid a rate to render the use of the product practical.

GROUP II. MECHANICAL

Because of their basic mechanical properties, phenolic molding materials are finding increasing applications in many fields. Sometimes electrical properties are essential and sometimes not. Most uses are based on either tensile or impact strength. Compressive strength of phenolic molding materials is sufficiently high that rarely is this property really a limiting factor. Recent developments in phenolic molding materials have placed emphasis on impact strength.

A. *General purpose materials.* The data under the same heading under Group I, Electrical, *A. General purpose electrical insulating materials* applies to general purpose materials. For most uses these materials are satisfactory.

B. *Exceptionally high impact-resistant materials.* A range of these materials is available. In considering them one should not choose a material with the idea that the factor of safety of the highest impact material will give him the greatest protection. In general, the higher the impact strength of the material, the more difficult it is to mold, particularly in molding pieces having thin wall section and long flow. Parts of this kind, due to the difficulty of molding, can often be produced from a material of relatively low impact strength, and they will withstand more shock than the same parts molded from a material of higher impact strength. Impact materials may be classified as follows:

1. *Improved impact-resistant materials.* In general, these products are about 50 per cent more shock resistant than the General Purpose Materials. The following table of properties is representative of improved impact-resistant materials:

Physical (Molded):
Specific Gravity 1.37, Weight per cu. in. 22.5 gms.
Tensile Strength 8500 lbs. per sq. in.
Modulus of Elasticity 10.0 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.23.
Impact Strength—Per Inch of Notch ft. lbs. 0.46.
Impact Strength—Lbs. Per Inch Square 2.88.
Molding Shrinkage .0075–.009 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Distortion Under Heat 275°F (135°C).
Water Absorption Gain 0.49% (48 hrs. immersion).
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 302°F (150°C).

Electrical (Molded):
Dielectric Strength at 60 Cycles 325 Volts per Mil.
Power Factor at 60 Cycles 0.30.
Power Factor at 1000 Cycles 0.10.
Power Factor at 1,000,000 Cycles 0.06.
Volume Resistivity 0.8 x 10^5 megohm cms.
Dielectric Constant at 60 Cycles 8–12.
Dielectric Constant at 1000 Cycles 8–12.
Dielectric Constant at 1,000,000 Cycles 5–7.

2. *Medium impact-resistant materials.* Often a material having greater impact resistance than that described in 1 is desired. Materials of this kind have been used for collector rings, panels, and similar parts that are subjected to shock. The following table of properties is representative in this class of medium impact-resistant materials:

Physical (Molded):
Specific Gravity 1.38, Weight per cu. in. 22.6 gms.
Tensile Strength 6500 lbs. per sq. in.
Modulus of Elasticity 10 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.35.
Impact Strength—Per Inch of Notch ft. lbs. 0.70.
Impact Strength—Lbs. Per Inch Square 4.40.
Molding Shrinkage .0065 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Water Absorption Gain 0.90%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 250°F (125°C).

Magneto part made from arc-resistant phenolic molding material

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Electrical (Molded):
Dielectric Strength at 60 Cycles 250 Volts per Mil.
Volume Resistivity 0.1 x 10^8 megohm cms.

3. *Medium-high impact-resistant materials.* This class is an improvement over 2. It has been used for football shoe cleats, instrument cases, etc. The following table of properties is representative of this class of medium-high impact-resistant materials:

Physical (Molded):
Specific Gravity 1.37, Weight per cu. in. 22.35 gms.
Tensile Strength 6500 lbs. per sq. in.
Modulus of Elasticity 10 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.70.
Impact Strength—Per Inch of Notch ft. lbs. 1.40.
Impact Strength—Per Inch Square 8.80.
Molding Shrinkage .0035–.0085 in. per in.
Flexural Strength 9000 lbs. per sq. in.
Water Absorption Gain 1.00%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 240°F (116°C).

Electrical (Molded):
Dielectric Strength at 60 Cycles 250 Volts per Mil.
Volume Resistivity 0.1 x 10^8 megohm cms.

4. *High impact-resistant materials.* These materials have been used for golf club heads and other parts where the highest resistance to shock obtainable is desired. The following table of properties is representative of this class of high impact-resistant materials:

Physical (Molded):
Specific Gravity 1.37, Weight per cu. in. 22.4 gms.
Tensile Strength 6200 lbs. per sq. in.
Modulus of Elasticity 10.0 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 2.32.
Impact Strength—Per Inch of Notch ft. lbs. 4.64.
Impact Strength—Lbs. Per Inch Square 29.00.
Molding Shrinkage .0035 in. per in.
Flexural Strength 9000 lbs. per sq. in.
Water Absorption Gain 0.63%.
Heat Resistance: Recommended for use where molded parts are subjected to temperatures up to 240°F (115°C).

Electrical (Molded):
Dielectric Strength at 60 Cycles 250 Volts per Mil.
Volume Resistivity 0.1 x 10^8 megohm cms.

C. *Improved tensile strength materials.* The general purpose materials have a tensile strength of 6,000 pounds per square inch or slightly over. For some applications, such as spinning pots (centrifuges) as used in the rayon industry, a special type of material having improved tensile strength has been developed. The following table of properties is representative of improved tensile strength molding material:

Physical (Molded):
Specific Gravity 1.36, Weight per cu. in. 22.2 gms.
Tensile Strength 8500 lbs. per sq. in.
Modulus of Elasticity 9.6 x 10^5 lbs. per sq. in.
Impact Strength—Energy to Break ft. lbs. 0.16.
Impact Strength—Per Inch of Notch ft. lbs. 0.32.
Impact Strength—Lbs. Per Inch Square 2.00.
Molding Shrinkage .006–.0075 in. per in.
Flexural Strength 10,000 lbs. per sq. in.
Max. Deflection at Center 0.065 ins.
Distortion Under Heat 275°F (135°C).
Water Absorption Loss 0.60%.
Water Absorption Gain 0.50%.
Heat Resistance: Recommended for use where molded parts are to be subjected to temperatures up to 302°F (150°C).

Electrical (Molded):
Dielectric Strength at 60 Cycles 350 Volts per Mil.
Power Factor at 60 Cycles 0.3.
Power Factor at 1000 Cycles 0.12.
Power Factor at 1,000,000 Cycles 0.05.
Volume Resistivity 1.7 x 10^8 megohm cms.
Dielectric Constant at 60 Cycles 10.
Dielectric Constant at 1000 Cycles 7.
Dielectric Constant at 1,000,000 Cycles 6.

GROUP III. CHEMICAL

In a broad sense, all phenolic molding materials have been considered chemical resistant. This is rather indefinite. For severe chemical conditions, special materials, which on test have shown resistance in accordance with the following table, have been developed. Conditions of test are so severe that general purpose materials would show up very unfavorably, so the properties of only the more chemical resistant materials have been listed. Materials are designated merely by arbitrary alphabetical letters.

Table of Properties for Water and Chemical Resistant Phenolic Molding Materials

Physical (Molded)	A		B		C		D		E		Rating above which material is not recommended for use.
Specific Gravity	1.43–1.45		1.78–1.80		1.42–1.45		1.8		1.46		
Tensile Strength	7000–8000		5526		7000		5105		7000–8000		
Impact Strength (per in. of notch ft. lbs.)	.12–.13		.449		.21–.22		.126		.12–.13		
Chemical (Molded)	**Wt. Change**	**Dim. Change**	**Wt. Change**	**Dim. Change**	**Wt. Change**	**Dim. Change**	**Wt. Change**	**Dim. Change**	**Wt. Change**	**Dim. Change**	
Water, 24 Hr. Boil (%)	+1.00	(zero)	+.043	+.52	+1.92	+1.13	+.60	+.80	+.651	+.542	
Rating	2		1		3		2		2		3
5% Sodium Hydroxide, 1 Hr. Boil (%)	+8.70	+10.30	+.20	+.72	+1.07	+2.10	+1.50	+2.20	+1.43	+2.36	
Rating	5		1		4		1		5		2
10% Sulphuric Acid, 24 Hr. Boil (%)	+2.89	+4.43	−19.53	(zero)	+1.67	+1.41	−16.13	+1.62	+.935	+.825	
Rating	4		Bad		3		Bad		2		2

Cumarone resin

(*Continued from page 37*) depolymerized, or broken down by heat, until temperatures far above 300°C. are obtained. The so-called pressure sensitive type of adhesive has been formulated satisfactorily with a cumarone resin base.

It is not a difficult matter to false-body, or increase the viscosity, of these adhesives so that they may be applied on porous fabrics or sheets with practically no loss of effect by penetration. Rubber cements containing such resin have very definite values. New uses with rubber and rubber products are being developed continually. The coating of paper has grown into a business of substantial magnitude. In that field cumarone has served to provide finish, waterproofing, gas proofing, stiffening and the like.

There are many other commercial uses of this resin, but the examples given will suffice to indicate how varied its usefulness is. Now, as for the future, a marked expansion in new uses seems certain. It is soluble in many oils. It blends well with many waxes, natural resins, pitches and other compounds. Such composites not only find use in themselves, but serve as starting points for other final products. This resin alone is not of value in lacquers, but when blended with various other substances it becomes compatible in the lacquer solution and remains compatible in the resulting lacquer film,—retaining its valuable properties. The blends with waxes, yield solids with many interesting possibilities.

Another field which has had considerable exploitation embraces combinations with other synthetic resins. The resin is compatible with ester gum, certain types of alkyd resin, some phenolic resins, and others. The resulting blends can be produced to meet very definite requirements which could not be met by either resin alone. The same statement holds true when blends are made with chlorinated rubbers inasmuch as each blend is designed to meet particular narrow specifications. The consumption of any one blend may not be great, and the total cannot be accurately estimated. The salient fact remains that it is a versatile resin capable of advantageous blending with many synthetic resins.

Although cumarone resin is often classed as a brittle resin, it should be remembered that such a classification does not apply to all grades and further that any brittle varieties can be easily plasticized and flexibilized. In view of such facts their increase in molding and laminating operations must be considered as an assured reality.

Developments in the use of cumarone in molding powders or in laminating varnishes go back beyond 1920. For years, however, every advance in molding and laminating was linked with thermo-setting resins,—and rightly so. Now we are looking to the role which cumarone resins may play. In variety and quality the present materials far surpass the original products. By themselves, or in conjunction with other synthetic resins they can meet many new conditions. That they will amplify and supplement thermo-setting resins in molding and laminating may well be considered as a reasonable possibility.

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Furfural-phenol resins

(*Continued from page 35*) dimensional accuracy and there is but little distortion.

7. The composition is very completely reacted and is therefore desirable in the production of molded articles which must resist high temperatures. When reheated the molded parts show a reduced thermoplasticity.

8. In transfer molding the long drawn out stage of plasticity at lower temperatures permits the use of a dual temperature arrangement whereby the material in the pressure chamber is plasticized by heating at relatively low temperature while the mold cavity is heated to a high reacting temperature. Under these conditions a supply of material may be retained in the pressure chamber for a period of approximately forty-five minutes and repeated successive moldings can be made during this period of time.

9. Where compositions in black and brown color are required, less pigmentation is called for, the color is uniform throughout the piece and is permanent even when exposed to sun or ultra-violet light. The completely cured part contains only a small proportion of uncombined phenol, if any.

10. Exceptional physical strength and high resistance to repeated impacts is available in phenol-furfural resins.

11. Excellent electrical properties where suitable fillers are used inasmuch as the reaction is substantially anhydrous.

12. Photographically sensitive surfaces in close proximity to the molded part are not fogged when a suitable phenol-furfural resin compound is used inasmuch as the cured pieces are relatively free from uncombined phenol.

Production

With the manifold advantages briefly sketched in this article it is to be expected and is a fact that many tons of these resins are produced daily. These resins while sold as molding compounds, are sold to the greatest extent as raw materials or resins which are used in the manufacture of compounds by many of the large molders in this country and there is a considerable amount of export in addition thereto. We have pioneered in this compound manufacture by the molders to enable them to provide a special compound most suitable for that particular molded part and in this way the molding of the part is engineered not merely from the standpoint of mold design, but also from the standpoint of the composition to be molded therein. In this manner the molder has the same latitude in molding composition as the molder of rubber parts in that he provides himself with a particular material ideally suited for the purpose as to flow, reactivity, chemical resistance, electrical requirements, etc. The molder is enabled to secure a larger per diem production from his mold cavities inasmuch as the molding composition is made to meet the requirements of the molding cycle production called for. The per diem production from a mold is often increased from twenty-five to fifty per cent where a special material is utilized as compared to the use of a standard material made to meet average conditions.

Ethyl cellulose plastics

(*Continued from page 31*) spermaceti, Japan wax, and the like. It is not compatible with paraffin, but a fluxing agent, such as rosin or one of the previously mentioned waxes, will render it miscible. In all cases where ethyl cellulose is soluble in a resin or wax, it increases the melting point and greatly improves the toughness, particularly at very low temperatures.

The melting point of ethyl cellulose is not sharp and lies within the range of 200-210 deg. C.; however, the softening point is 110-130 deg. C., which is the proper range for working on rolls or in a Banbury mixer. On exposure to ultra-violet light from a Mercury Quartz Arc the relative discoloration developed by ethyl cellulose in comparison with other cellulose derivatives was as follows:

Nitrocellulose	.596
Benzyl Cellulose	.580
Cellulose Acetate	.250
Ethyl Cellulose	.154

A high index indicates the development of more discoloration.

The moisture absorbed by ethyl cellulose in comparison with other cellulose derivatives was determined by drying five gram samples for three hours at 105 deg. C., followed by exposure to 80 per cent relative humidity for 24 hours at room temperature in a closed container.

Cellulose Acetate	8.4 per cent
Ethyl Cellulose	3.4 per cent
Nitrocellulose	3.1 per cent

In making a plastic with ethyl cellulose, the material is worked up as a heavy paste on a two-roll mill with the hot roll at a temperature of 120 deg. C. At this temperature the ethyl cellulose forms a very heavy plastic which is sufficiently fluid to permit incorporation of pigments. The pigment is uniformly dispersed in the paste after a few minutes of mastication; the required amount of plasticizer may then be worked into the mass.

After cooling, the hard sheets are disintegrated in the usual manner. The usual pigments, colors and fillers may be used. It will be noted that no volatile solvent is necessary in making this plastic and that the process from raw material to finished molding powder may be carried out with unusual directness and speed. The use of water-wet pigment will be found to be advantageous in that it will not fly around the room at the time of mixing, and as soon as the pigment touches the hot mass the water immediately flashes off. A Banbury mixer can likewise be used for incorporating pigment and plasticizer; but, in this case, dry pigment should be used.

From the physical properties of ethyl cellulose, it is obvious that it has some distinct advantages in molding plastics. It can be readily compounded and produces exceptionally tough plastics; it is light-proof and consequently can be used for delicate pastel shades; it has unusual toughness, particularly at low temperatures; it is easy to handle in ordinary molding equipment; it is resistant to most chemical influences and is not inflammable; it has excellent electrical characteristics; and finally, it opens up a new field for the production of thermoplastics with resins and waxes.

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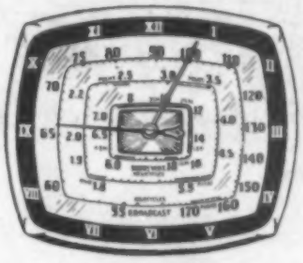
GEMLOID  DIALS

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RÖHM & HAAS COMPANY, INC.
222 West Washington Square
PHILADELPHIA, PA.

Acrylic resins

(Continued from page 32)

Brinell	19–21
Tensile Strength	7000–10000 lbs.
Flexural Strength	11700–14000 lbs.
Impact Resistance (A.S.T.M. notched bar)	2–3 ft. lbs./sq. in.
Heat conductivity	0.1827 K cal./m°C.h
Cofficient of Expansion	0.00012/°C.
Water absorption	1.25% (equilibrium value)
Dielectric Constant	3.0–3.6
Volume Resistance	10^{12} ohms/cm³

This resinous glass is supplied in the form of plane or curved sheets in thickness from .060 to .240 inch. Sheets as large as 36 by 48 inches are available. In addition to the water white sheets, it may be obtained in a variety of colors. Its transparency and light weight suggest its use for windows in all types of vehicles, and since it is available in sheets curved in two or three dimensions, it is particularly suited for use in windows in modern stream-lined vehicle bodies. Its attractive appearance makes it useful for spectacle frames, fountain pens, mechanical drawing instruments, hospital equipment, watch crystals, safety goggles, and many novelty articles. The optical properties of acrylic resin make it suitable for prisms and lenses in optical instruments.

Solutions of the acrylic resins may be used for coatings, adhesives, impregnation, electrical insulation, and for numerous other purposes. In one form[3] it has proven quite suitable for use in the manufacture of a laminated glass.

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[3] Plexiqum is used in laminated glass marketed under the name Plexite which is registered in the U. S. Pat. Office.

Casein plastics

(Continued from page 30)

desired shape or size with abrasive stones or wheels.

The fine and lasting polish which can be applied to casein plastic is one of the valuable features of the material. Articles may be polished by hand, using cotton mop buffs. This is the usual method for small quantities, but in general practice, polishing is done with a "chemical dip polish." The articles are first tumbled with pumice to remove tool marks and scratches. They are then "washed" in a hypochloride solution, similar to Javelle Water, rinsed and dried. This reduces the time and the cost for polishing to a minimum.

The principal uses for casein plastic in the United States are for buttons, buckles, slides and accessory trimmings. The material is hard enough to wear well and keep its polish, yet it may be worked with sufficient ease to create distinctive designs, or to be used for mass production. The fine colors, which have depth and beauty to a degree available in few other materials, and which are known for their dependability, rarely fading or changing with age, have made casein plastic one of the most satisfactory materials for the manufacture of such merchandise and accessories.

Aside from the ornamental uses, casein plastic is used by manufacturers of electrical equipment and appliances. Its insulating qualities are sufficient for many purposes, and many items of this sort are made from rods on automatic screw machines.

The comparative properties in the accompanying chart are based upon maximum and minimum figures submitted by a number of manufacturers of each type of plastic material. The figures have been carefully checked for accuracy by engineers of various companies and finally, by the U. S. Bureau of Standards at Washington, D. C.

PROPERTIES	PHENOL-FORMALDEHYDE COMPOUNDS						PH FUR
	Woodflour Filler	Mineral Filler	Fabric Filler	Laminated Paper	Laminated Fabric	Cast Resins	Woodf
Molding Qualities	Excellent	Excellent to fair	Good to fair	—	—		Ex
Molding Temperatures, ° F.	300°–350°	270°–330°	270°–330°	250°–350°	250°–325°	—	33
Molding Pressures, lbs. per sq. inch	2000–4500	2000–6000	3000–8000	1000–3000	1000–2000	—	10
Compression Ratio	2.5–3.0	2.2–7.1	2.5–11.0	—	—	—	2
Specific Gravity	1.34–1.52	1.79–2.09	1.37–1.40	1.2–1.4	1.3–1.4	1.27–1.32	1
Specific Volume, cubic inch per lb.	20.4–18	15.3–13.5	20–19.5	20–22	20–22	20–23	21
Tensile Strength, lbs. per sq. inch	6000–11000	5000–10000	6500–8000	6000–13000	8000–12000	8000–12000	500
Compressive Strength, lbs. per sq. inch	25000–36000	18000–36000	20000–32000	20000–40000	—	15000–30000	280
Impact Strength, ft. lbs. per sq. inch	1.00–3.5	1.4–4.5	5.0–30	5–15 (Izod)	10–65 (Izod)	1–2.5	1
Modulus of Elasticity, lbs. per sq. inch x 10^5	10–25	10–45	7–12	5–20	5–15	5–25	
Mold Shrinkage, inches per inch	0.006–0.10	0.002–0.006	0.003–0.007	—	—	—	0.0
Thermal Conductivity, 10^{-4} cal., per second centimeter degree centigrade	4–12.2	8–20	0.03–5	5–8	5–8	3–5	3
Thermal Expansion, 10^{-6} per degree centigrade	3	2	4.5	2–3	2	2.8	
Specific Heat, cal. per degree centigrade gram	0.35–0.36	0.25–0.35	0.30–0.35	0.3–0.4	0.3–0.4	0.3–0.4	0.
Heat Resistance, ° F.	300°	400°–500°	250°–350°	225°–300°	—	160°	
Water Absorption, % by weight, 48 hrs.	0.2–0.7	0.01–0.15	1.0–1.3	0.2–4.0	0.2–2.0	0.01–0.05	0
Volume Resistivity (a) (b) (c) (d)	10^4–10^8 (a)	10^4–10^5 (a)	0.4×10^5 (a)	1–10 (b)	0.1–1.0 (b)	2×10^5	4
Breakdown Voltage, 60 cycles, volts per mil (instantaneous)	300–500	250–400	300–450	500–1300	200–600	300–450	4
Dielectric Constant, 10^6 cycles	4.5–8	4.5–20	4.5–6.0	4.0–6.0	4.5–7.0	5–7	
Power Factor, radio frequencies	3.5–10	5–10	4–10	2.0–5.0	2–8	1–4.5	1
Dielectric Constant, e and f	4–8 (f)	4.5–20 (f)	4.5–6.0 (f)	—	—	—	
Power Factor, e and f	4–15 (f)	10–15.0 (f)	8–20 (f)	—	—	0.5–8.0	
Hardness, 2.5 mm. ball, 25 kg. load, depth in 1/200 mm	—	—	—	24–40	—	—	35–4
Softening Point, ° F.	Chars	—	—	—	—	—	
Refractive Index N_D	—	—	—	—	—	1.5–1.7	
Burning Rate	Very low	Nil	Practically nil	Very low	Very low	Nil	V
Effect of Age	None	None	None	Improves mechanical and electrical properties		None	In
Effect of Light	Lighter shades discolor		←	Lowering of surface resistance from ultraviolet		Practically no effect	Ligh
Effect of Weak Acids	None to slight depending on acid		←	←	←	No effect	
Effect of Strong Acids	Marked effect depending on acid		←	Depending on temperature and kind of acid		No effect	Dec
Effect of Weak Alkalis	Slight to decided effect		←	←	←	None	Slowl
Effect of Strong Alkalis	Decided effect		←	←	←	Slight pitting	Disi
Effect of Solvents	None on bleed-proof materials		←	No effect	No effect	None	
Metal Inserts	Inert	←	←	←	←	None	
Machining Qualities	Fair to good	←	←	—	—	Excellent	
Clarity	Opaque, mottled effects		←	Opaque, mottled, graining possible.	all colors and Black, natural,	Opaque, translucent	O
Color Possibilities	Unlimited	←	←	chocolate, red, number of other	green. Limited colors.	Water clear	Dar

* Charpy.

(a) Megohms centimeters.

(b) 10^{10} ohms

Cast Resins	PHENOL-FURFURAL	UREA FORMALDEHYDE	VINYL RESINS		ACRYLATE	STYRENE	SHELLAC COMPOUND	No Refra
	Woodflour Filler		Unfilled	Filled				
—	Excellent 330°–400°	Excellent 260°–325°	Excellent 240°–275°	Excellent 250°–300°	Good 280°–340°	Good 293°–375°	Good 240°	Fa —
—	1000–3000	2000–5000	1500–2000	2000–2500	2000–3000	300–2000	1000–1200	4000–1
—	2.5–3.0	4	2.0	1.5–3.5	1.3–1.4	2.5	—	2.5
1.27–1.32	1.3–1.4	1.46–1.50	1.34–1.36	1.35–2.5	1.19	1.04–1.054	1.1–2.7	1.9
20–23	21.3–19.8	18.8–18.5	20.5	20.5–11.0	23.1	26.6	10–25	14
8000–12000	5000–12000	5000–13000	8000–10000	6000–12000	8000–9000	5600–9600	1000–1200	—
15000–30000	28000–36000	24000–35000	—	—	—	13000–13500	—	120
1–2.5	1.0–6.5	2.0–2.4	0.3–0.6 (Izod)	0.1–0.7 (Izod)	0.26 (Izod)	0.4	—	0.4
5–25	—	16	3.5–4.1	3.5–8.5	0.45	4.6	—	—
—	0.005–0.007	0.007–0.011	0.001	None	0.002–0.003	0.0035	—	0.0
3–5	3.5–5.0	1.7	5.4	—	4.3–6.8	1.9	—	—
2.8	3	—	7.0	—	7.0	10.2	—	—
0.3–0.4	0.30–0.40	—	0.244	Varies	0.45	0.324	—	—
160°	280°	160° continuous	—	—	392°	—	—	500
0.01–0.05	0.3–0.6	0.4–4.0	0.05–0.15(24 hrs.)	0.2–0.7	0.2–0.35 (7 days)	Zero	—	1.5
2×10^9	4560 (a)	2.4×10^7 (a)	$>10^{14}$	—	$>10^{15}$	10^{18}	—	—
300–450	400–600	300–550	400–500	350–400	480	2600	100–400	85
5–7	—	6.0	4.0	4.0	2.8	2.4–2.96	—	—
1–4.5	1.0–6.0	3.0	1.75	2–6.5	2.0	0.004	—	—
—	—	7.0 (e)	—	4.7	3.0 (50)	2.4	—	—
0.5–8.0	—	3 (e)–1.6	1.43 (1000)	2–15 (f)	2.0 (50)	0.0002	—	—
—	35–40 (500 kg.)	48–50(500 kg.-10 mm.)	15–25	15–25	20 (10 mm.)	—	—	—
—	—	None	Wide range	Softens over wide range	131°–196°	110–199.4	150°	—
1.5–1.7	—	1.54–1.6	1.53	—	1.503	1.67	—	—
Nil	Very low	Very low	Nil	Non-inflam.	Slow	Low	High	Nil
None	Improves	None	Strength unaffected	None	None	No effect	—	—
Practically no effect	Light colors darken	None	Darkens	Slight discoloration	None	Sunlight yellows	—	—
No effect	None	No effect to practically no effect	Resistant	Dependent on filler	No effect	No effect	Decomposes	Practi no ef
No effect	Decomposes	Decomposes	Resistant	Dependent on filler	No effect	No effect	Decomposes	Decom
None	Slowly softens	No effect	Resistant	Dependent on filler		No effect	Decomposes	Decom
Slight pitting	Disintegrated	Slight effect	Resistant	Dependent on filler		No effect	Decomposes	Decom
None	None	No effect	Resists alcohol, aliphatic hydrocarbons and oils	Soluble in acetone, ketones	Soluble	Widely soluble	Alcohols	—
None	Inert	Inert	—	Inert	—	—	—	Ine
Excellent oque, translucent	Fair Opaque	Fair Opaque, translucent	Very good Opaque translucent, transparent	Good Unlimited opaque and translucent	Very good Transparent	Poor to readily Glass clear	Poor Opaque	Poo Opaq
Water clear	Dark shades	Unlimited; pastel shades	Unlimited	Pastels to black	Unlimited	Unlimited	Limited	Dark colo

(b) 10^{10} ohms per cubic centimeter.

(c) At 30° centigrade 10^{10} ohms per cc.

	COLD MOLDED		CHLORINATED RUBBER	RUBBER HYDRO-CHLORIDE	HARD RUBBER	CASEIN	CELLULOSE ACETATE		CELLULOSE NITRATE	
	Non-Refractory	Refractory					Transparent	Pigmented	Pyroxylin	
	Fair	Fair	—	—	Fair	Poor	Excellent	Excellent	Very good	Molding
	—	—	—	—	285°–350°	200°–225°	275°–340°	250°–400°	185°–248°	Molding
	4000–12000	4000–12000	—	—	1200–1800	2000–2500	2000–5000	2000–3000	2000–5000	Molding inch
	2.5	3.5	2–3	3	—	—	2.4	2.4	—	Compre
	1.98	2.20	1.5	1.06	1.12–1.40	1.35	1.27–1.37	1.56	1.35–1.60	Specific
	14	12.6	18.4	25.0	20–25	20.5	21.9–20.2	17.8	17–20	Specific lb....
	—	—	—	4300	4000–12000	7600	2800–6000	2500–9000	1000–10000	Tensile inch.
	12000	16000	—	—	8000–12000	—	4000–16000	11000	—	Compre sq. in
	0.40*	0.40*	3.0*	2.6 (Izod)	0.5 (Izod)	1.0 (Izod)	1.2–5.2	2.2	10–11.5 (Izod)	Impact inch.
	—	—	—	4.7	5.3	5.07–5.7	1.47	2.61	2–3.9	Modulu sq. in
	0.015	0.000	—	None	—	—	0.0025	0.0045	—	Mold inch.
	—	—	—	2.6–2.9	3.2	—	5.4–6.5	5.3–8.7	3.1–5.1	Therma per s centi
	—	—	—	7–8	8.0	8–1	15.6	10.2	12–16	Therm degre
	—	—	—	—	0.33	—	0.43	0.36	0.34–0.38	Specific centi
	500°	1300°	248°	—	—	—	—	—	Decomposes 212°–300°	Heat R
	1.5	10–15	—	0.02 (24 hrs.)	—	4–10	1.9–3.5	1.4–3.5	1.0–3.0 (24 hrs.)	Water 48 hr
	—	—	—	(5–7) × 10^{14}	10^{12}–10^{16}	—	4.5 × 10^{14}	—	(2–30) × 10^{14}	Volume
	85	—	2300	—	250–900	400–700	590–1000	470–600	300–780	Breakd volts
	—	—	—	2.68 (1000)	3.0	6.8–6.15	4.3	4.9	6.15	Dielect
	—	—	—	0.16	0.3–0.8	5.19	5.7	5.9	7.4–9.7	Power
	—	—	ca. 3.0	2.7 (e)	2.8 (e)	—	8.4	12.0	7.3–6.7 (e)	Dielect
	—	—	0.003	0.6 (e)	—	—	7.7	15.3	6.2–14.4 (e)	Power
	—	—	—	85–90 (Shore)	31	23	45–65	45–65	45–65	Hardne load.
	—	—	174°–230°	167°–221°	150°–190°	350° dry heat	120°–180°	160°–230°	160°–195°	Soften
	—	—	1.56	—	—	—	1.49–1.50	—	1.5	Refrac
	Nil	Nil	Nil	Slow	Medium	Nil	Very low	Very low	Very high	Burnin
	—	—	Slight embrittlement	None	Deteriorates	Hardens slightly	Very slight	—	Slightly harder	Effect
	—	—	Darkens	Slight surface crazing	Discolors in sunlight	Colors might fade	Slight discoloration, tends to become brittle		Discolors and becomes brittle	Effect
es	Practically no effect	Decomposes	Resistant	Good resistance	Unaffected	No effect	Slightly affected	←	No effect	Effect
es	Decomposes	Decomposes	Resistant	Good resistance	Not attacked by sulphuric if less 1.35 Sp. G.	Decomposes	Decomposes	←	Decomposes	Effect
es	Decomposes	No effect	Resistant	Good resistance	No effect	Softens	Slightly affected	←	No effect to gradual decomposition	Effect
es	Decomposes	No effect	Resistant	Good resistance	No effect	Softens	Decomposes	←		Effect
	—	No effect	Soluble	Attacked by some	Acetone softens and deteriorates	Decomposes	Acetone, acetates, lactate, essential oils, alcohol, etc.		Alcohol, esters, etc.	Effect
	Inert	Inert	—	—	—	—	Inert	←	—	Metal
	Poor	Poor	—	Good	Machines fairly well	Good	Good	←	Good	Machi
	Opaque	Opaque	Translucent, opaque	Transparent	Opaque, translucent, opaque		Opaque, translucent, transparent		Opaque, translucent, transparent	Clarity
	Dark colors only	Gray	Unlimited	Unlimited	Blacks, browns, reds limited	Unlimited	Unlimited colors		Unlimited	Color

(d) Surface at 50% relative humidity. (e) 60 cycles. (f) Audio frequen

CASEIN	CELLULOSE ACETATE		CELLULOSE NITRATE	PROPERTIES
	Transparent	Pigmented	Pyroxylin	
Poor	Excellent	Excellent	Very good	Molding Qualities
200°–225°	275°–340°	250°–400°	185°–248°	Molding Temperatures, ° F.
2000–2500	2000–5000	2000–3000	2000–5000	Molding Pressures, lbs. per sq. inch
—	2.4	2.4	—	Compression Ratio
1.35	1.27–1.37	1.56	1.35–1.60	Specific Gravity
20.5	21.9–20.2	17.8	17–20	Specific Volume, cubic inch per lb.
7600	2800–8000	2500–9000	1000–10000	Tensile Strength, lbs. per sq. inch
—	4000–16000	11000	—	Compressive Strengths, lbs. per sq. inch
1.0 (Izod)	1.2–5.2	2.2	10–11.5 (Izod)	Impact Strength, ft. lbs. per sq. inch
5.07–5.7	1.47	2.61	2–3.9	Modulus of Elasticity, lbs. per sq. inch x 10^5
—	0.0025	0.0045	—	Mold Shrinkage, inches per inch
—	5.4–6.5	5.3–8.7	3.1–5.1	Thermal Conductivity, 10^{-4} cal., per second centimeter degree centigrade
8–1	15.6	10.2	12–16	Thermal Expansion, 10^{-5} per degree centigrade
—	0.43	0.36	0.34–0.38	Specific Heat, cal. per degree centigrade gram
—	—	—	Decomposes 212°–300°	Heat Resistance, ° F.
4–10	1.9–3.5	1.4–3.5	1.0–3.0 (24 hrs.)	Water Absorption, % by weight, 48 hrs.
—	4.5×10^{13}	—	$(2–30) \times 10^{13}$	Volume Resistivity (a) (b) (c) (d)
400–700	590–1000	470–600	300–780	Breakdown Voltage, 60 cycles, volts per mil (instantaneous).
6.8–6.15	4.3	4.9	6.15	Dielectric Constant, 10^6 cycles.
5.19	5.7	5.9	7.4–9.7	Power Factor, radio frequencies.
—	8.4	12.0	7.3–6.7 (e)	Dielectric Constant, e and f.
—	7.7	15.3	6.2–14.4 (e)	Power Factor, e and f.
23	45–65	45–65	45–65	Hardness, 2.5 mm. ball, 25 kg. load, depth in 1/200 mm.
350° dry heat	120°–180°	160°–230°	160°–195°	Softening Point, ° F.
—	1.49–1.50	—	1.5	Refractive Index N_D
Nil	Very low	Very low	Very high	Burning Rate
Hardens slightly	Very slight	—	Slightly harder	Effect of Age
Colors might fade	Slight discoloration, tends to become brittle		Discolors and becomes brittle	Effect of Light
No effect	Slightly affected	—	No effect	Effect of Weak Acids
Decomposes	Decomposes	—	Decomposes	Effect of Strong Acids
Softens	Slightly affected	—	No effect to gradual decomposition	Effect of Weak Alkalis
Softens	Decomposes	—		Effect of Strong Alkalis
Decomposes	Acetone, acetates, lactate, essential oils, alcohol, etc.		Alcohol, esters, etc.	Effect of Solvents
—	Inert	—	—	Metal Inserts
Good	Good	—	Good	Machining Qualities
Opaque, translucent, opaque	Opaque, translucent, transparent		Opaque, translucent, transparent	Clarity
Unlimited	Unlimited colors		Unlimited	Color Possibilities

(e) 60 cycles.

(f) Audio frequencies.

MOLDING and FABRICATING

Designing and Engineering Molds
Mold Making and Using
Molding Technique
Preforming
Molding with Preforms
Transfer Molding
Screws and Inserts
Inlays and Overlays
Cold Molding
Resin Boards and Blanks
Fabricating
Machining
Color Molding
Pages 109 to 226

Designing for plastics production

BY HAROLD VAN DOREN*

NOT many years ago, six or seven perhaps, the widespread use of plastics for decorative purposes was unheard of. The phenomenal increase in their employment for cosmetics, radios, watches, smokers' accessories, even rather large retail store equipment, can be attributed to a number of factors. For one thing, the availability of brilliant color and pastel shades. Durability of surface, accuracy of dimension, extreme lightness. Perhaps most of all, the desire for something new, something different.

Since the previous use of plastics had been largely industrial and utilitarian rather than decorative, appearance played a comparatively small part. Hence effective and artistic design in the plastic molding field, has a slim background. Personally I believe that the possibilities for beautiful design in plastics have hardly been touched, that the next few years will see the development of designs in the plastic field at the hands of talented and experienced men that will deserve admission to museums along with the best of modern glass, ceramics and silver.

It so happened that about 1930, when plastic moldings were beginning to be talked about as alternatives for paper, metal, glass and other materials, we were on the toboggan slide into the blackest chasms of the well-known Depression. Manufacturers who were flirting with plastics had no money to spend and, if a designer were called in to give the *coup de grace* to a cigarette box or a pocket flashlight, he was told, like as not, that molds were frightfully expensive, and to design the article so that the molds could be carved out on machine tools with a minimum of hand work.

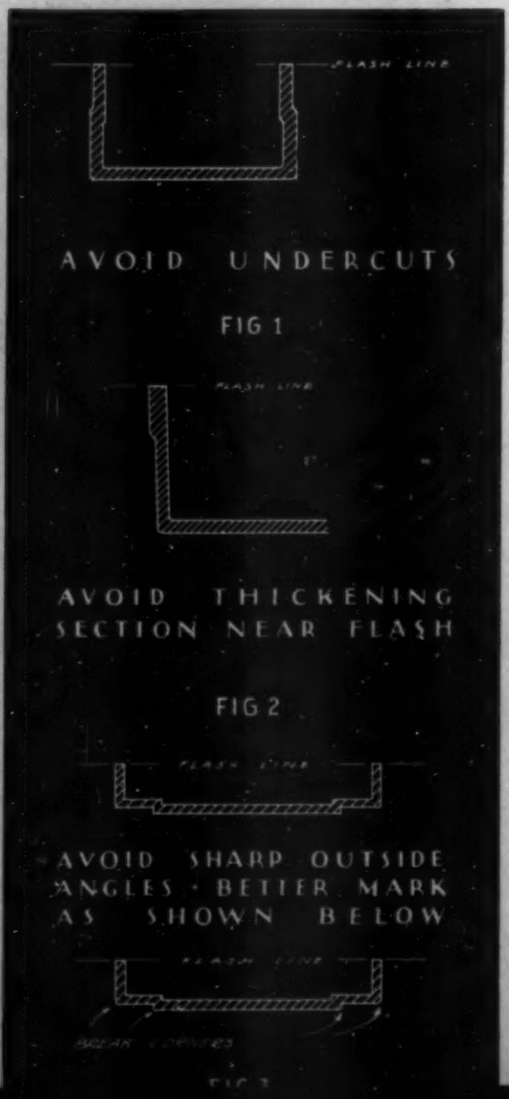
Therefore, most of us who were designing for plastic users at that time kept scrupulously to straight lines, ribs and flutes, and avoided freehand curves like the plague. It was naturally very limiting, but there was a certain exhilaration about producing something attractive in spite of limitations, like the poet who must keep his sonnet to fourteen lines.

Since then, many developments have occurred to make the designer's lot easier, and to give him greater latitude. For this article, I have been asked to talk about the production of a molded piece from the designer's point of view, and to discuss specifically the do's and don'ts of plastic designing.

The actual mechanical design of plastic molds is taken up in this issue by another far more competent than I. It will do no harm, however, to trespass on his property for a moment and define a few fundamentals. By far the greatest number of plastic moldings are made on power-operated presses, into which are fixed two-part molds of hardened steel. The lower half of the mold is usually stationary and is called the cavity or female mold. The upper half travels vertically at the end of a ram and is called the force, or the male part of the mold. The two halves, at the moment of maximum downward travel of the ram, exert pressure plus heat on the molding material; the material becomes plastic, or "flows"; then it hardens or "sets" into its permanent final shape. The inside contours of the molded piece conform to the shape of the force; the outside contours of the piece conform to the shape of the cavity.

Some pieces are designed to remain in the cavity when the force is pulled out, others to cling to the force and to be removed by a stripper plate or other means. Therefore, the first lesson learned by the beginner in plastic design is to *avoid undercuts*. It is so simple and obvious that it seems almost ridiculous to mention it, but it is curious how often even an experienced designer will blithely bring his design almost to completion and suddenly discover that one would not be able to remove it from the mold after the plastic is "set." (Fig. 1.)

For easy removal from the mold, every plastic piece, unless it be very shallow, must have a small amount of draft. This is a matter which need not unduly disturb the artist-designer, for it may be, even in a very deep piece, only a few thousandths of an inch. In fact it is rather common practice for the designer, in pre-



* Harold Van Doren and Associates

paring his mechanical drawings showing the exact dimensions of the finished piece, to mark his drawings "no draft shown" and leave this to the draftsman who prepares the actual mold drawings.

The thickness of section of any molded piece is strictly a matter for determination in each individual case. In general it can be said that the designer should figure his sections as thin as is compatible with the ultimate use of the piece. Much money has been wasted making molded articles twice as thick as is necessary to obtain needed strength, thereby doubling the cost of material and increasing the length of the molding cycle.

The best moldings are obtained from pieces designed so that the thickness of section decreases as it nears the flash. Therefore, the designer should avoid adding beads around the edge, for this sudden thickening of section makes it difficult for the material, already beginning to "set up" as it travels from the bottom of the cavity, to flash quickly and make a clean molding. (Fig. 2.)

The fact that plastic molding is capable of producing sharper and cleaner lines and edges than almost any other known material, has led many designers to overdo them. A box, for example, can be molded in plastics with a ninety-degree corner almost as sharp as a knife, but the resultant feel of the molded piece is seldom pleasant. If the nature of the design, however, calls for rather sharp treatment, better mark drawings with the notation "break edge" or even give a dimension such as one-sixty-fourth or one-thirty-second radius, or a decimal. Remember that this outside angle on the molded piece is an inside angle in the cavity of the mold, and if you make it too sharp to begin with, you can't add steel afterward to correct the condition. On the other hand, if the radius is too large, it can always be reduced later by machining out the cavity. (Fig. 3.)

FIG 7

FIG 8

Sharp inside corners on the finished piece may also cause a lot of trouble, but for a different reason. Granted, it may be a great temptation to use clean-cut lines and planes, but the appearance of many a molded piece, which looked beautiful when it came fresh from inspection, was distressing after a week on the desk or the living-room table. Dust settles in these sharp crevices, and the dust-cloth is powerless to remove it. The article has to be washed with a brush and soap, or each crevice cleaned separately with a cloth backed up by a sharp instrument. The oil from even clean hands gathers grime and makes this condition worse. I have seen radio knobs in ivory or white with finely cut lines which have to be removed and washed every week or look grimy. If you must have an inside corner, give it enough of a fillet, a thirty-second if possible, so that after the article is in use it is easily cleaned. This is especially important in food store equipment where sanitation must be paramount. See Fig. 4 at the left.

Another error frequently committed by the beginner in plastic molding is in misjudging the amount of relief necessary to give an effect. I have seen many plastic designs ruined because the designer did not realize that these highly glossy materials need very little relief to make surface decoration telling. Letters raised one-sixty-fourth of an inch are entirely readable, because they catch *(Continued on page 223)*

Molds—how they are made and used

BY EDWARD F. BACHNER *

To those who are inclined to believe that mold costs are high yet who have not taken the time or trouble to investigate how they are made, this portrayal of the necessary steps to be taken in tool preparation should be a revelation. Add to these preparatory steps the man hours of hobbing in heavy equipment and the hand labor required in finishing and polishing, and mold costs, whatever they are, become reasonably justified.
(Editor's note)

1 Engineering staff at Chicago Molded Products Corp. in the center of which is the author of this article

To the uninitiated a mold is little more than an uninteresting piece of metal on which a few man and machine hours have been spent and from which in some mysterious way plastic parts are produced. He has, perhaps, never seen a complete mold with all its necessary accessories, nor does he realize the thought, care and skill required for its conception, design, fabrication and operation.

If you are one of the uninitiated it might interest you to acquaint yourself by means of the following description and pictures with what is involved in the production of a mold. Let us assume that a customer has conveyed to the molder by blueprints and specifications, the general appearance and application of the part he has in mind to be molded and the probable number of pieces he will require yearly or monthly. The first step in mold production requires a study of these blueprints and specifications to determine

1st Is it a practical molding job?

2nd The kind of material to be used—which will to some extent determine—

3rd The type of mold needed.

4th In what position is the part to be molded.

5th The size (number of cavities) needed to meet customer's production requirements.

6th What extra operations, if any, are required; such as drilling, tapping, finning, sanding, buffing, polishing, etc.

7th What accessories such as drill jigs, gauges, biscuit dies, loading fixtures, cooling plates, etc., are needed.

8th What change in design should be suggested, which, without affecting the mechanical requirements or general appearance of the part will so simplify the molding procedure as to bring about desirable production economies.

In a well organized plant, this study is made by a staff of engineers, each of which is in charge of one or more phases of production. In Fig. 1 we have the engineering staff in consultation, with the customer's blueprints and specifications before them. At the head of the table is the chief of the engineering staff, and about the table the engineer in charge of mold design, the engineer in charge of estimating, the superintendent of the tool room, the engineer in charge of molding operations and the superintendent in charge of production are grouped.

The blueprint discloses that the piece to be molded is a handle for use on gas stove drawers and oven doors—a very practical molding job. Standard wood flour base phenolic material is selected because of its excellent heat insulating qualities, strength and lustrous finish. Quantity requirements warrant an eight cavity semi-automatic steam mold—the handle to be molded face down. To avoid duplication of somewhat complicated machining operations, the cavities for the mold shall be hobbed. The plungers not being adaptable to hobbing will be machined.

One of the engineers calls attention to the fact that the blueprint shows a radius on both walls at the underside of the handle. To mold these radii would necessitate parting the mold midway between the upper and lower edges of the handle which would leave a fin or parting line, hard to remove without spoiling the finish of the piece. These radii are im-

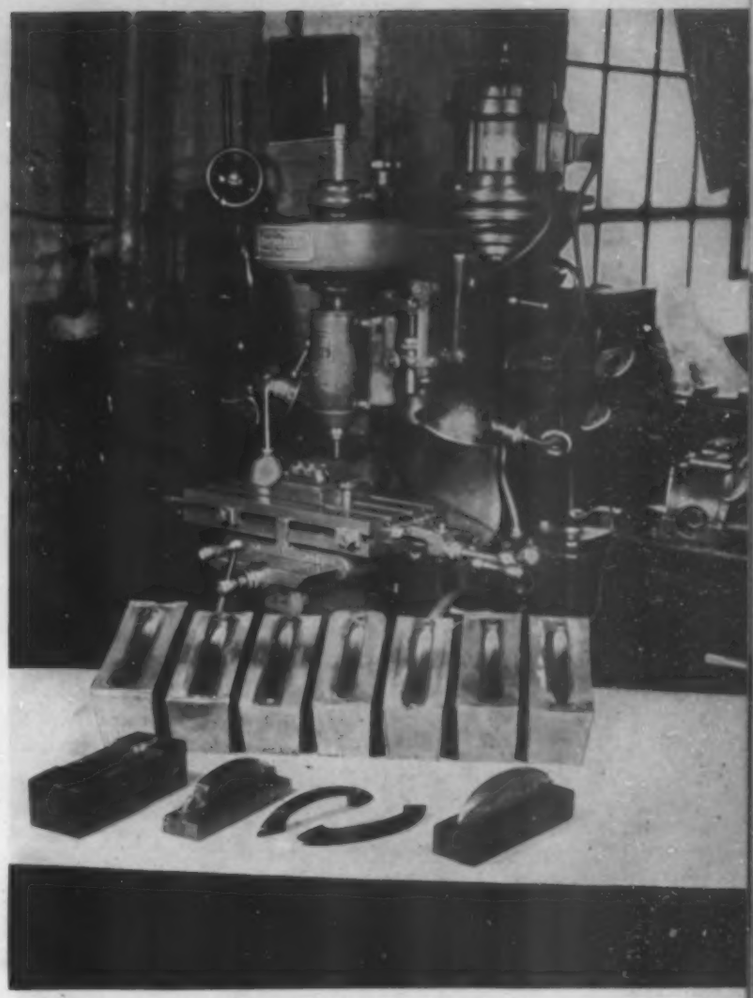
* General Manager, Chicago Molded Products Corp.

portant—sharp edges where the hand grasps the handle are not desirable. He suggests therefore that the piece be molded with a straight edge, the parting line of the mold to follow the contour of the underside of the handle and the radius be given to the piece after molding by means of a special cutter.

A hole is to be molded in each end of the handle and later tapped, which operation will require the design and making of a tapping fixture. To facilitate loading the mold, a biscuit (or tablet) will be used instead of loose powder and a biscuit die be designed and made to suit. The handle will be buffed in the usual manner. From this study the chief of the engineering staff determines the sizes, quantities and kinds of steel to be used for the hob, for the sinkings or cavities, for the plungers, for the nest or frame, for the knock-out pins, for the biscuit die, and for the special cutter.

All steel is not alike

For the hob, a chrome tungsten molybdenum tool steel is specified because of its high compressive value and resistance to shock. For the sinkings a low carbon steel,—one that offers least resistance to the hob, that insures even flow of the metal; that extrudes readily into the cavities and that will insure exact reproduction from the hob. For the plungers, tool steel that machines freely and that hardens without distortion. For the frame a mild machine steel forging which will require no hardening as it serves only to hold the sinkings in position. For the knock-out pins, drill rod, and



Above—Mold cavities showing force, hob, and molded handle in the tool room at Chicago Molded Products Corp. Below, is the hobbing press

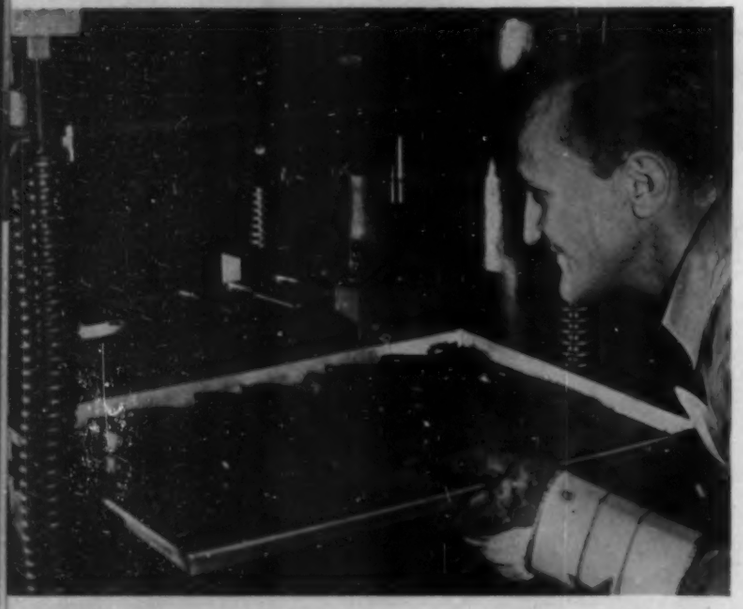
2

3

for biscuit dies, a water hardening tool steel of good wearing quality. For the special cutter a carbaloid tool bit is used, as phenolic molded materials dull ordinary tools quickly. Each of these steels or alloys require a different heat treatment and it is the knowledge and experience of the chief engineer that insures not only the right selection of metal but the proper handling of it in the hardening process.

These preliminaries having been decided upon, orders are issued for the purchase of the various steels to be used. In the meantime, under the supervision of the engineer in charge of mold design, drawings are made of the hob, plungers, cavity and frame for the mold, of the biscuit die, tapping fixtures and special cutter. Under direction of the estimating engineer, piece part drawings and specifications are prepared covering every phase of the production procedure and copies delivered, with blueprints when ready, to those in charge of the various operations.

The drawing of the hob being finished, the first operation is that of machining the hob, which after being hardened and polished is ready for the hobbing process. Fig. 2 shows a 1500 ton hobbing press with hob in position ready to be forced into the soft steel sinking block in the press bed. The tremendous pressure exerted forces this hardened steel hob slowly into the soft, cold steel block, leaving an exactly reproduced cavity for the bottom of the mold.



4 Removing finished parts from a molding press in operation

In Fig. 3 we see seven of the eight sinkings just as they come from the hobbing press. Note that the tops of the blocks are somewhat distorted from the flow of the metal caused by the tremendous pressure exerted by the hobbing process. In the left foreground is shown one sinking which has been fully machined, hardened and made ready for the mold. Next to it on the right is one of the eight plungers, also fully machined and hardened, and next to this two samples of the molded parts. In the right foreground is the hardened and polished hob from which the sinkings are made. Fig. 4 shows the mold complete, set in the press and in operation.

As each part is molded, it is given a preliminary inspection and either rejected or passed on for the tapping operation and the machining in of the radii. After these two operations, a second inspection is made before the parts are sent to the polishing room for buffing. After buffing they are given the final inspection and then sent to the shipping department for delivery to the customer.

Hardening the mold

And now, let us now go back to the hardening processes, perhaps one of the most important steps in the making of good molds, and one that requires good judgment, skill and considerable experience. The chrome tungsten molybdenum tool steel hob after being machined to shape is placed in an electric furnace and heated to a temperature of 800 deg. F. This comparatively low temperature distributes the heat uniformly throughout the piece and eliminates possible distortion or cracking. It is really a preparatory step in the process, and after that the temperature is raised to 1600 deg. F. and the part is then quickly immersed or quenched in a fish oil bath, after which it is allowed to cool slowly. This gives the piece hardness but leaves it more or less brittle, and so to give it the necessary toughness and resistance—to "draw" or "temper"—it is slowly reheated to 300 deg. F. and then allowed to cool. Now we have a hard, tough hob which requires only careful polishing. A mirror like polish is necessary, for even the slightest hair line scratch will be reproduced in the sinking and again in the molded part. For the first polish, fine emery cloth is used; for the final finish, any of the various polishing compounds, with plenty of hand rubbing.

The sinkings of low carbon steel require very different handling, in the hardening process. Packed in carburizing compound, like powdered charcoal, and placed in an airtight box they are kept at about 1600 deg. F. for from twelve to thirty-six hours, depending upon the depth of case desired. The heat is then turned off and the sinkings are removed from the pack, placed in an electric furnace, reheated to 1450 deg. F. and then quenched in fish oil. They are now ready for the polishing operation.

The plunger or male forces of non-deforming tool steel are first pre-heated to about 800 deg. to 1000 deg. F. then given the final heating of 1450 deg. F. and then quenched in oil. Their temper is then drawn by reheating to 600 deg. F. after which they are allowed to cool slowly and are now ready for polishing. The knock-out pins of drill rod are usually hardened by the cyanide process which consists of heating potassium cyanide to 1500 deg. F. in which the rods are suspended until thoroughly heated, then quenched in oil and no further tempering is necessary.

Biscuit dies are heated in the electric furnace to 1450 deg. F., quenched in water and their temper drawn by reheating to 400 deg. F. The carbaloid tool steel cutter requires no heat treatment, it has received its tempering before it reaches the mold maker and requires only fastening, by brazing, in the tool handle.

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Technique for molding

BY E. E. WOODMAN*

PRESSURE

PERHAPS the most important condition in molding phenolic materials is the pressure applied to the material. It is this pressure that causes the powder to fill out the mold cavity. It also determines the thickness of the ever present fin with its consequent influence on finishing costs. The effective pressure also has its bearing on the time of cure, the finish and the strength of the molded part. In spite of its important functions it is often carelessly estimated in designing a mold or installing a plant and in some instances is even forgotten entirely.

At least 2,000 lbs. per square inch effective pressure on the molded part should be allowed. This must be based on the horizontal area of the piece. In the case of overflow molds the area of the cut-off land where the top and bottom parts of the mold come together, must be taken into consideration. In positive molds or unit-loading (subcavity) molds, all land area must also be allowed for. The figure of two thousand pounds per square inch should be used for comparatively flat pieces only and on those with high side walls requiring a deep draw, an extra seven hundred pounds per square inch should be allowed for each inch of wall height. These figures are of course meant for materials of standard strength and plasticities. Extra strength and certain special materials require greater pressure.

While material manufacturers are now able to produce molding compound that can be molded under much lower pressure, there are certain inherent disadvantages in these softer materials. A stiff material molded under high pressure produces the most glossy smooth finish—one that is free from "dog skin." Where conditions in a plant require especially soft materials, it is almost impossible to obtain a satisfactory finish on parts of a decorative nature without resorting to cooling which slows the operation, results in increased cost and more than loses the advantage hoped for when a few more cavities than really should have been were put in the mold.

Effect of pressure on cure

Pressure has a great influence on rate of cure. Of course with high pressure a stiffer material can be used and stiffer materials under the same pressure in nearly all cases cure faster than softer types. It is an interesting fact that the same material molded under 1,500 lbs. per square inch and then under 3,000 pounds per square inch, will sometimes cure in half the time under the latter condition as the former. Possibly the extra steam pressure causes the material to flux more rapidly and thoroughly, and, at the same time, causes a quicker transfer of heat units from the mold to the material due to the closer contact of the mold and the compound under the higher pressure. The plant using a higher pressure has a distinct advantage over the one using a lower pressure in obtaining fast cures and consequent high production.

Effect of pressure on strength

Pressure also influences strength. A molded part should have at least ten thousand pounds per square inch transverse strength but with low pressure and a very plastic material necessarily used the strength is apt to run under this figure. Parts low in strength can cause unlimited trouble and complaints. While the material manufacturer makes all possible strength tests on each blend of compound as it comes through his plant, the test pieces are molded under ideal conditions and unless the material is eventually molded under favorable conditions, there is no guarantee that the finished parts will have the strength rightly expected of them by the ultimate user.

When specially soft materials must be used because of low pressure conditions, there is often danger of after shrinkage. It is generally accepted that parts shrink seven to eight thousandths of an inch on being taken from the mold. This is allowed for in designing the mold and if the shrinkage stops then all is well. Shrinkage stops when the material is thoroughly cured. Lack of cure causes it to go on shrinking to some extent. Stiffer materials cure more thoroughly than softer ones and hence the danger of after shrinkage with its resultant inaccuracy of dimensions. Warping and cracking around inserts is far greater when a very plastic material must be used.

Effect of pressure on rejects

The majority of rejects are "light" pieces (those that have not properly filled out), pieces with heavy fins that are oversize and must be thrown out. With an excess of pressure would there be any rejections for these reasons? Watch the bad pieces come out of the mold some day when the hydraulic pressure suddenly drops to half what it should be. This drop in line pressure creates an exaggerated condition of too low a pressure which is instantly obvious.

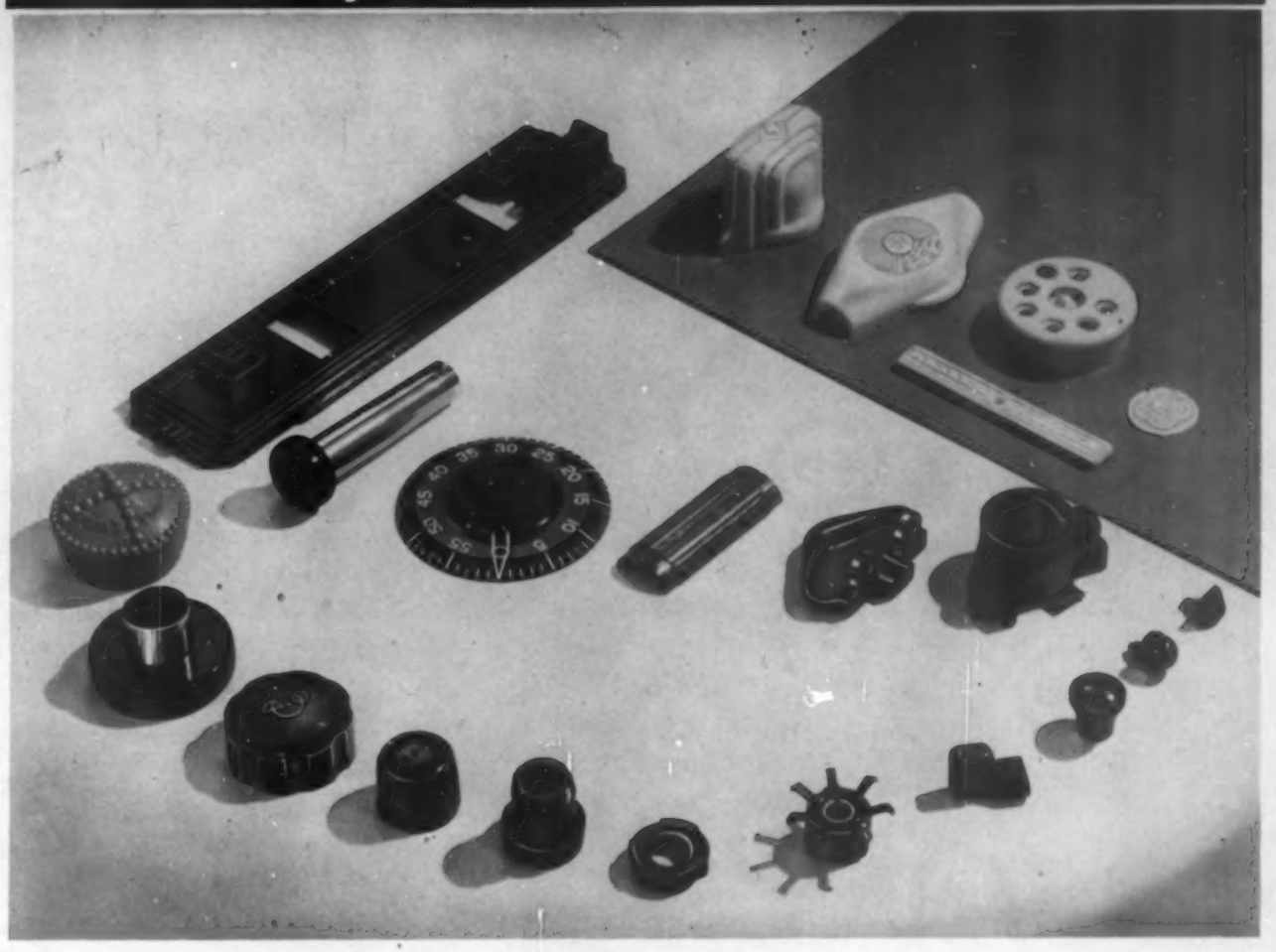
It is a great temptation to put too many cavities in one mold in order to save on the direct labor cost but this hoped for saving can be lost in so many other ways that it seems highly important to consider the pressure carefully.

HEAT

Of equal importance to pressure, is the heat applied to the material in the molding operation. The function of the heat is twofold. First, to soften the material and put it in a plastic state so that the pressure may force it throughout the mold cavity and flux it into a solid homogeneous mass. Second, to cause the polymerization of the resin which results in the material curing and hardening into an insoluble infusible

* General Plastics Inc.

Variety Plus in Plastics



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Open press showing molds ready to fill. (Photo, courtesy General Plastics, Inc.)

mass. Looked at from this viewpoint, it is readily seen that the lack of sufficient heat may play havoc with the molding operation. Under too low a temperature the molding compound does not soften as it should and appears to be too stiff to properly fill out the mold cavity. A properly heated mold takes advantage of the maximum plasticity of a material. There are many cases on record where a mold that would not fill out satisfactorily was made to run properly by raising the temperature above that ordinarily used.

But the effect of heat on cure is even more important. A certain number of heat units are naturally required to transform a given quantity of molding compound from the powder form to the finished molded state. Naturally the quicker these heat units can be transferred from the mold to the material the shorter will be the curing time. To get the quickest results the mold must be hot to start with and plenty of heat units must be available for immediate use. Steam has proved to be the most practical means of supplying the necessary heat due to the fact that it not only supplies heat units in being reduced in temperature, but also gives them off in far greater quantity in condensing to water because of the factor of latent heat of vaporization.

Low steam pressure

Unfortunately many molding plants have been installed without sufficient steam pressure available. Most boilers for ordinary heating purposes are rated at only a hundred or a hundred and twenty-five pounds. Presses are installed to use this available steam rather than incur the expense of a special boiler for higher pressures. There are even some cases of plants using steam as low as ninety pounds pressure. Such conditions mean molds at comparatively low temperatures, and the plant is seriously handicapped in competing with others where steam pressures up to two hundred and seventy-five pounds are used. The difference in curing time which determines the production from a mold may be a hundred per cent between these two conditions. A pertinent example along this line is the case of one company which happens to mold the same part (a rather large one) in two different plants. At one plant the steam pressure is one hundred fifty pounds and the complete cycle on the press is seven minutes. At the other with a steam pressure of two hundred twenty-five pounds the cycle requires only four and one-half minutes. It takes no great mathematician to see that the higher steam pressure in this case means an increase in production of fifty-five per cent. Obviously, steam pressure can't be boosted without radical changes, but there are many ways in which the present available heat can be conserved and made to do a bigger job.

The ideal mold from the standpoint of heating is the direct heated mold in which the steam circulates in the mold block itself, close to the cavities. In a mold of this type the heat loss thru radiation is far less than where a mold is heated from contact with a platen. Also the transfer of heat units to the material is quicker and more efficient for there is a short direct path thru the metal. Still there are great differences in molds of this type, for sometimes sufficient care is not taken in the design to see that all parts of the mold are heated as uniformly as possible and that there will be a large enough volume of steam going thru the mold to supply plenty of heat. The mold de-

Why So Many
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BEETLE is the favored plastic in a wide variety of industries. More and more manufacturers and designers are realizing its many practical advantages for improving the usefulness and attractiveness of their products. New uses are continually being discovered for Beetle. Here are a few industries in which its strength, beauty and adaptability have been convincingly demonstrated:

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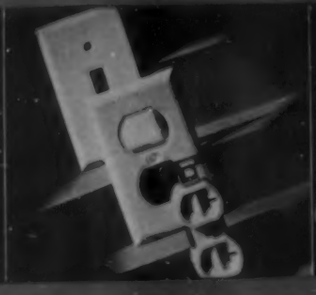
IN LIGHTING—because it is non-shatterable, has remarkable diffusing qualities and meets the stringent I.E.S. specifications for reflectors. Lamp bases and fixtures also are being molded of Beetle.

IN COSMETIC CONTAINERS—because of its rich, unlimited range of colors; its resistance to chemicals plus its absence of odor and taste makes it highly desirable for this purpose.

IN INSTRUMENTS—Beetle offers the advantages of a full range of colors, durability, ease of handling, light weight and lustrous appearance. The ease of assembly is likewise an important consideration.

IN AUTOMOBILES—Beetle in dome lights, gear shift and instrument knobs gives lasting service and adds a dash of color and beauty. Its shatter-proof qualities suggest other uses in this field.

IN JEWELRY BOXES—Beetle is ideal because of the expensive-looking effects that can be achieved with its rich color and beauty. Its adaptability to small, intricately molded packages makes it ideal for this purpose.



IN ELECTRICAL FIXTURES—because Beetle is a non-conductor of electricity, is strong and durable, it gives long-lasting service in plugs and sockets. Bright colors add decorative and sales appeal.

IN HARDWARE—knobs and handles for stoves, refrigerators, etc., Beetle is smooth to the touch, easy to keep clean, cannot rust. Further adaptations are anticipated.

IN LUGGAGE ACCESSORIES—for instance, in picnic sets, Beetle is bright, cheerful to look at, hard to break, easy to wash and light to carry.

IN RADIOS—in the radio industry Beetle has made a hit by adding beauty of sight to beauty of sound, with smart, handsomely molded cabinets. Beetle is resistant to severest climatic conditions.

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signer who studies these points carefully is well rewarded for his pains.

Hand molds

When hand molds are used in platen-equipped presses the loss of heat is found to be large and every possible means should be taken to prevent it. Since the heat is transferred from the platen to the mold it is very important that there be a close contact between the mold and the platen. Keeping the outside surfaces of platens and molds smooth and clean is important. Platens dented and containing spots of cured material cause a poor contact and greatly increase the heat loss. Platens often become partly clogged from scale and sediment deposited and consequently cut down on the volume of the steam flow. They should frequently be checked and cleaned or replaced when necessary. Steam traps may misbehave and cause platens to fill up with water and consequently lower the temperature. Hand molds, of course, tend to cool off considerably while they are out of the press and care should be taken that they be replaced in the press just as quickly as possible to avoid too much loss of heat. In many cases it is well worth while to keep them on a hot platen while they are being loaded.

Some heat losses can be eliminated by using insulation. If the platens are not properly insulated from the presses a great deal of heat is dissipated in the ram and frame of the press. Inch-thick boards of asbestos placed under the platens are a great help here. Asbestos can also be used to advantage around the sides of the platen or the mold. Covering steam pipes with asbestos reduces line loss to a large extent, particularly where pipes are long or exposed to cold air. Sheltering presses from the cold draft from windows is also well worth while. There are cases where an open window or door has caused material to blister on a curing time that was ordinarily satisfactory.

It is also important that material be at least as warm as room temperature when it is used. Cold material put in the mold can make a difference of half a minute in the cure.

MOLDING HINTS

"Breathing" of the mold (opening the mold for a few seconds just after the initial close in order to allow the entrapped gases to escape) will often remedy such troubles as pitting of the finished surfaces and blistering. The defects are caused by materials which produce a considerable amount of gas during the molding process.

A certain amount of experimenting is required to ascertain how long the mold should be closed before it is breathed. Normally, about 15 seconds is required. The "breathing" period should be from 15 to 30 seconds duration.

It sometimes happens that the material being used on the job is too soft and tends to escape through the flash orifices before the part is filled out. This may be corrected by closing the mold to within a half- or three-quarters of an inch of the final closed position. This position should be held for a period varying from 15 seconds to 60 seconds, or until such time as the material has stiffened enough to mold properly.

Occasionally a die is encountered which, because of an intricate shape or a poor die design, will not run properly when both platens are at the same temperature. For instance if there are certain areas in the bottom part of the die that require a long flow of material and will not fill out under ordinary conditions, the die may be made to run by holding the top platen at a lower temperature. Or, if a channeled mold is used in which it is possible to run cooling water, results can be obtained by cooling the top die to a desired lower temperature.

Curing

The cure of a molded part is of the utmost importance. If a part is under-cured, blistering, shrinkage, poor finish and warpage may all occur. These may be corrected by either a longer cure or by securing a faster cure material.

In the black or brown materials a slight over-cure is not detrimental but this does not hold good in colors, for there an over-cure will often darken the color and give a two-toned effect to the finished part.

Very often colors have to be run at a lower steam pressure to prevent this color change and it is well to load the molds rapidly and apply pressure as soon as possible.

As most industrial uses of plastic materials require that the finished molded part be held to very close dimensional limits, the shrinkage of a part is important. The piece should be thoroughly cured and the shrinkage can be still further reduced by a long cool period while the part is still in the die and by mounting on shrinkage fixtures after ejection from the die.

Preheating is coming into extended use, as it shortens the cure period required in the die and speeds up production. The pelleted material is placed on a hot plate or in an oven and there heated at about 175° F. just before it is loaded into the dies for molding. The preheating of colored materials will give a more even color and eliminate a tendency to mottle on the lighter colors.

Storage

Changes in atmospheric conditions have a very definite influence on the molding characteristics of compounds. A good rule to follow is: "Store in a warm, dry place." Material stored in a damp place or subjected to high humidity conditions will have a higher plasticity and a slower cure than when originally made. This change in characteristics is much more evident in asbestos-filled materials than it is in wood-flour material and makes itself evident in poor finish, pitting and sticking to the mold. These defects can be remedied by spreading the material in a thin layer and placing in an oven for a period of one to two hours at a temperature of 100° Fahrenheit.

In dies where there are a number of inserts or where the filling out of intricate parts requires a long flow of material, it is quite possible to get a material that is too fast in cure or too stiff. Both of these faults will make themselves evident by about the same symptoms—that is, difficulty in closing the mold and finished parts which are not filled out.

If such trouble is encountered, materials of varying plasticities and cures should be tried until one is found that gives the desired results.

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Preforming and its equipment

BY JOHN A. SILVER* AND CHARLES BOSS*

Single punch preforming press. (All photos, courtesy F. J. Stokes Machine Co.)

PREFORMING, as applied to the plastics industry, consists of compressing the various plastic molding powders into "pills" or tablets of the proper weight and shape to facilitate their handling and storage and to make possible the operation of the molding presses on a production basis. Preforming combines volumetric weighing—which is the older method of providing the desired charge of material for the molding press—with "pilling" and frequently simplifies and makes less expensive the construction of the mold itself. Production is speeded up, rejections are reduced and the finished product is improved. Because of the importance of preforming, the industry has been demanding preforming machines which operate faster, are subject to a minimum of interruption, produce a more perfect preform and one which can be fed more rapidly to the molding press.

Types of presses

There are two distinct types of presses used for preforming work; a single-punch model, and the rotary preforming press which carries a number of pairs of punches and dies and has a considerably higher production of preformed or "pills" per minute. The single-punch type is satisfactory for general work where production is limited or where a number of special shapes or large-size pieces are involved. Rotary preforming presses are primarily production machines for making preforms at the rate of 200 to 600 per minute. However, they are now being economically used on limited production by operating the press with as few pairs of punches and dies as the job requires. Thus the die cost, a factor to be considered, is kept down while retaining the advantages of greater speed and at the same time great reserve capacity.

* F. J. Stokes Machine Co.

Choosing a preforming press

The choice of a preforming press, single-punch or rotary, depends upon the maximum diameter or the diagonal of the piece to be made, upon its thickness or weight and, as mentioned above, upon the production desired. In other words, the larger the preform, the larger and more expensive must be the preforming press to produce it. However, it has been found in many cases that, in making certain types of molded pieces, several small preforms can be substituted for one large round or special-shaped preform. This sometimes permits the use of a smaller, faster and less expensive single-punch press or, for a slightly greater investment, fast rotary preforming presses having several times the production of the single-punch model. The use of the smaller, less expensive dies on the smaller single-punch and rotary models makes the job practical from a profit standpoint, when the limited quantity of finished molded parts to be produced does not warrant making up a set of punches and dies to make a large preform.

Insuring uninterrupted production

One of the most serious problems in the preforming department—interrupted production caused by jams and breakdowns—is more likely to occur today than formerly, owing to the demand for harder pills and the fact that, because of the demands of the molding department, presses are usually operated at the maximum pressure they will apply. Standard molding powders contain particles of different sizes, as well as a certain proportion of fine powder mixed with granules and unless the precaution is taken to tumble the drums of material before tableting, trouble in the form of a stalled machine is very likely to result. This is because, in a mixture of fines and granules, the fines will settle and when later fed into the machine which had been properly set for compressing the granules at the top of the drum, the change in compression ratio may overload the machine or jam it.

When urea molding compounds are used, the likelihood of such happenings is often increased, since they require somewhat more pressure per square inch to form a pill of a given diameter than do the phenolic resins and a smaller change in the compression ratio may cause the press to jam. To meet this problem, various devices have been developed. In one case the device operates automatically and can be adjusted to meet various operating conditions while the press is running. By means of a special graduated and adjustable spring, operating through a lever or system of levers, all strains are absorbed and overloads spilled without the disruption of production formerly encountered. This device is available both on single-punch and rotary model preforming presses and it will even prevent jamming or stalling on centers, should a portion of a previously made preform or some foreign substance in the material being compressed be charged into the die.

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Variable speed drive

Whenever a single-punch machine is used, the advantages of a variable speed drive should be considered. Such a drive soon pays for itself by the increased production it permits on certain sizes of preforms or with different molding compounds. Certain molding compounds also have a tendency to laminate because of the air trapped in them, and a slower pressure or longer "dwell" help to make a pill which otherwise would be impossible. A "Speed Change" is most helpful in such circumstances in that it permits maximum production rather than a lower fixed production which must take care of all conditions. It also frequently enables a machine to "pill" materials which otherwise could not be handled on a single-punch press.

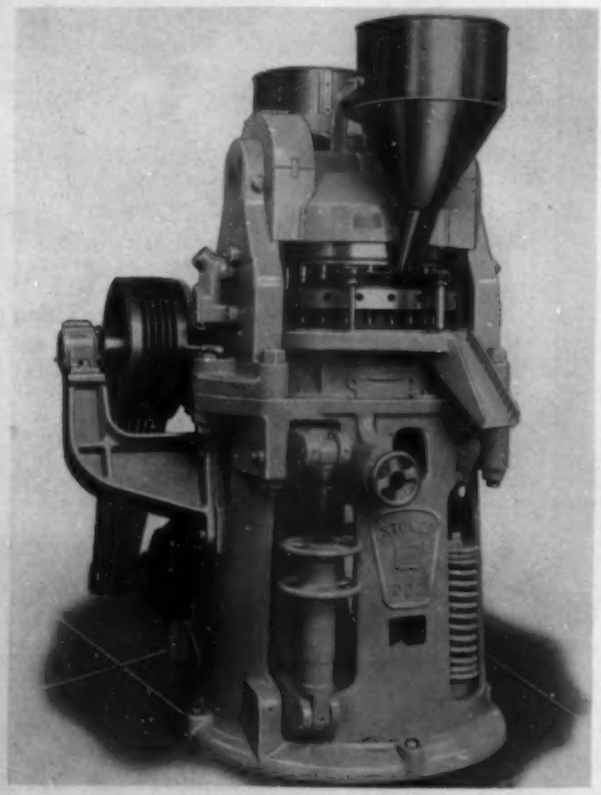
Advantages of rotary presses

Returning to the use of multiple preforms wherever they can be used, the advantages of the rotary type of preforming press over the single-punch press should be seriously considered. In the first place, the preforms made on a rotary machine are usually of more accurate weight and density. Accuracy is obtained by overfilling each die cavity and scraping off excess material before compressing. The preforms made are formed by a slow squeeze simultaneously from both sides, giving the same hardness to the bottom of the preform as to the top, a result impossible on the standard single-punch machine which usually compresses only from the top. Preforms of more accurate weight mean a saving in material and less "flash," while an additional saving is made possible by eliminating crumbling and providing preforms of closer weight tolerances for the molding press.

On the rotary press, molding compounds containing much powder can be made into excellent and satisfactory preforms which, if compressed in a single-punch machine, would produce laminated "pills." This is due to the slow squeeze of the rotary press and the fact that during this longer compressing interval the air in the powder has time to escape. Operation of the machine is smoother and it has been proven that less pressure is required to make a piece of a certain diameter on a rotary machine than on a single-punch model. These presses, also, are easy to clean and "change-over" from one size of preform to another or from one color to another. They are usually furnished with dust-collecting nozzles at each compression point and with housed working parts. When used for limited production on different sized pieces—only one size of which can be made at a time—quick "change-over" is made possible by leaving the press set up with several different die sizes, with plugs in those cavities not used; when any one of these sizes is to be made, the corresponding upper and lower punches are slipped into place quickly and without tools or material loss of the operator's time.

In certain of the rotary preforming presses available today, the die fill is frequently as much as on large single-punch machines. In other words, many pieces which formerly had to be made on the single-punch type of press simply because a certain depth of fill in

Rotary preforming presses in which moding material is tableted before reaching the press room



News of the Day at the Executive's Desk

Market reports, commodity prices, and national radio programs are brought to the executive's desk by the new Sengbusch AIRITE, which combines a fine radio, clock, and writing set in one compact unit.

Only molded plastics could provide the combination of advantages necessary for its handsome case—lightness, strength, economy of manufacture, permanent beauty of finish, and insulation against both heat and electricity.

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If this were the only example of such confidence, it would perhaps mean little. But Sengbusch is only one of the long list of prominent manufacturers who regularly bring their exacting molding jobs to this organization—a list which today reads like a blue book of American industry.

This confidence is based on something far deeper than fine mechanical equipment and adequate production facilities, although these are important considerations. Its foundations, rather, lie in things which cannot be bought—years of broad experience, unsurpassed engineering skill, and an organization which functions as an efficient unit in the production of perfect molded pieces.

Whatever the nature of your plastic molding problem, you, too, can bring it to Chicago Molded with confidence—confidence that the mold will be designed for best results and most economical production, that every piece will meet your most exacting requirements, and that the deliveries will be on time to meet your schedules.

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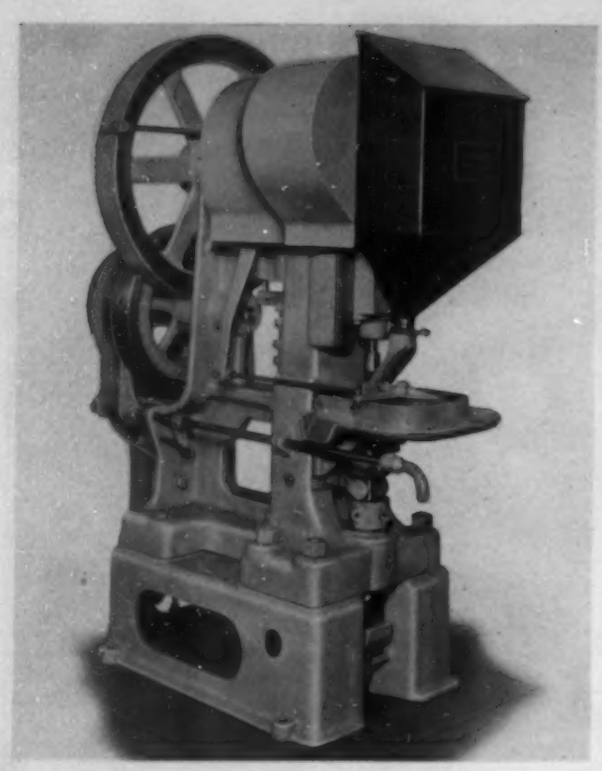

Single punch heavy-duty preforming press

the die was necessary, can now be transferred—with approximately the same tool cost for the same production—to great advantage to the rotary machine which has the added possibility of five to ten times the production of the single-punch model. The much greater production of the rotary machine is not realized, nor is it understood with how few pairs of punches and dies of any one size the production of the rotary model would equal that of the single-punch machine. In the case of one rotary machine on the market, the use of three pair of punches and dies (out of a total complement of 23) would more than equal the production of a large heavy-duty press costing nearly as much.

Disadvantages of use of multiple punches with single-punch presses

As a general rule multiple punches for single-punch presses are not recommended. In the first place, multiple punches and dies are costly and are time-consuming to set up. Further, they have a very decided tendency to produce preforms of inaccurate weight and varying densities with resulting rejections of the final molded pieces. This results again from the composition of the molding compounds. Assuming a single-punch machine set up with multiple punches and dies, those cavities nearest the back or throat of the feed shoe receive a heavier charge, since most of the fine powder sifts into them. On the other hand, the coarser granules are fed into the further cavities and lighter preforms result. Nor do the charges in the further cavities receive as much pressure as the others. Since operators have a tendency to increase the pressure unduly in order to make these lighter preforms as dense as those which contain more of the fine powder, a jammed press frequently results with possibly a broken punch and die set and costly production delays. Wherever multiple punches and dies are now used, the making of such pieces can usually be transferred to a rotary type of press on which they can be made accurately, more economically and with no such attendant difficulties.

Advantages of ball-shaped preforms

The ball-shaped preform is one of which the molders of plastic compounds could take greater advantage. This ball shape is made by means of round dies and inexpensive punches, and it can be handled and loaded more rapidly into the hot presses. When using multiple preforms, balls are a great convenience and if necessary or advisable it is practical to preheat them while rolling them into position in the molding press. This reduces the length of curing time. The ball shape has the decided advantage of so crushing to powder in the press that there is no dividing line to show where the several preforms flowed together. A typical application where they are used to advantage is in making long narrow pieces which otherwise would require preforms of a special shape, involving loading difficulties.

Care of punches and dies

Proper attention to the care and design of punches and dies would save much trouble now frequently encountered in preforming departments. In the first place, dies which have a ring worn in them at the compression point should be reversed, assuming that the compression point was sufficiently above or below the center of the die, or they should be ground or lapped out to permit ejection of the preform without its having to pass through a narrower diameter than that in which it was formed.

Of importance also is the clearance of the lower punch of the preforming press and the design of the relief used in it. Considering first this relief, it should be of the sharp-shouldered or square type made by undercutting in the lathe, rather than grinding the finished punch. This sharp shoulder keeps the material which passes the lower punch from building on the die wall whereas the "rounded" relief made by grinding increases the friction and instead of scraping the die wall clean, it acts as a wedge with this material to cause operating difficulty.

The clearance of the upper punch in the die, as well as the clearance between the lower punch and the die should be more than is now current practice. This is particularly true where urea molding compounds or those containing considerable powder are made into tablets. By increasing the clearance between the upper punch and the die, air can escape which otherwise would trap and cause lamination on ejection of the preform.

Manufacturers of preforming presses have had wide experience with the problems which the user encounters and, if consulted, are often able to make suggestions which enable the user to overcome his operating difficulties and turn failures into profitable jobs.

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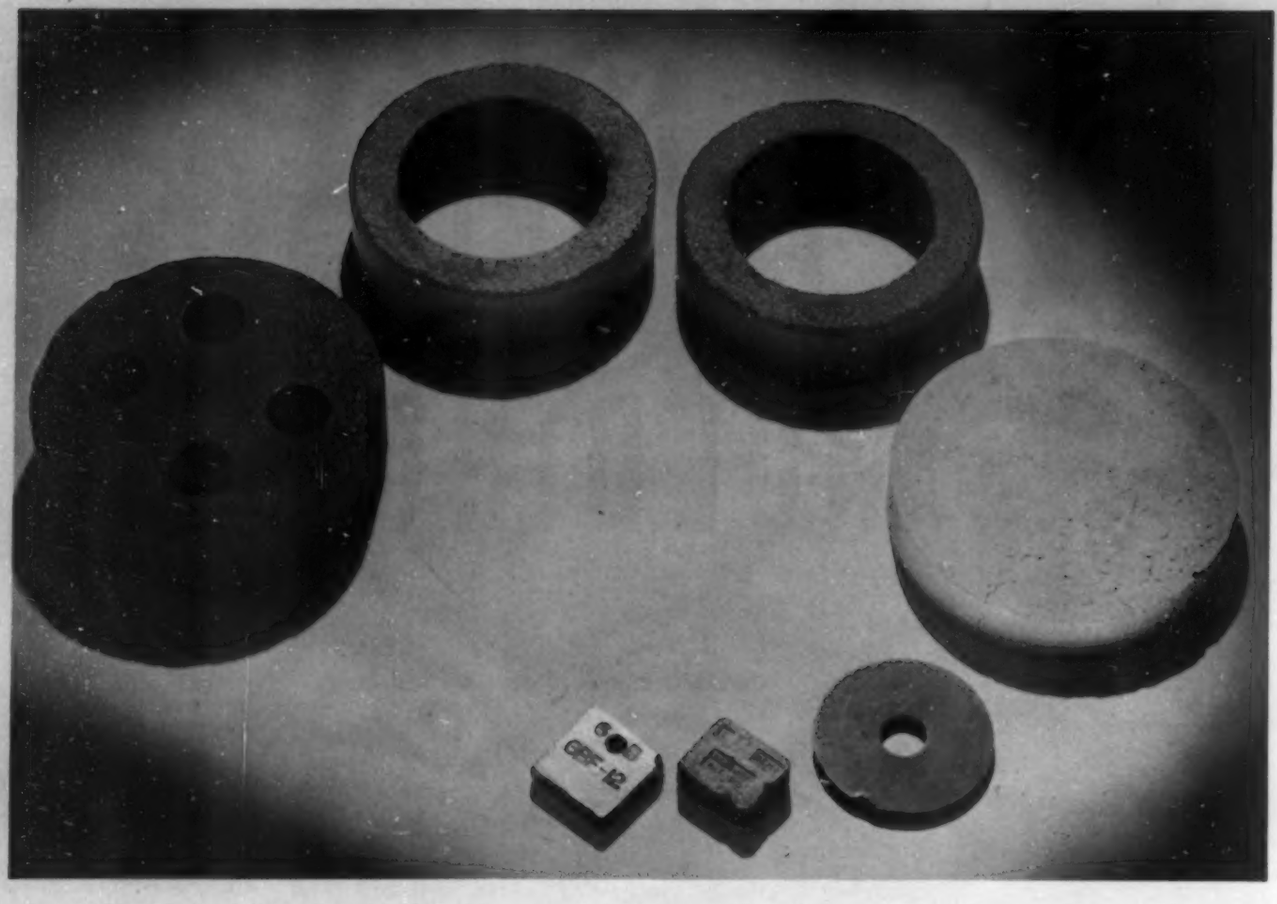


This shows the molding composition pressed into preforms of varying shapes and sizes

Molding with preforms

BY V. H. CRAGGS*

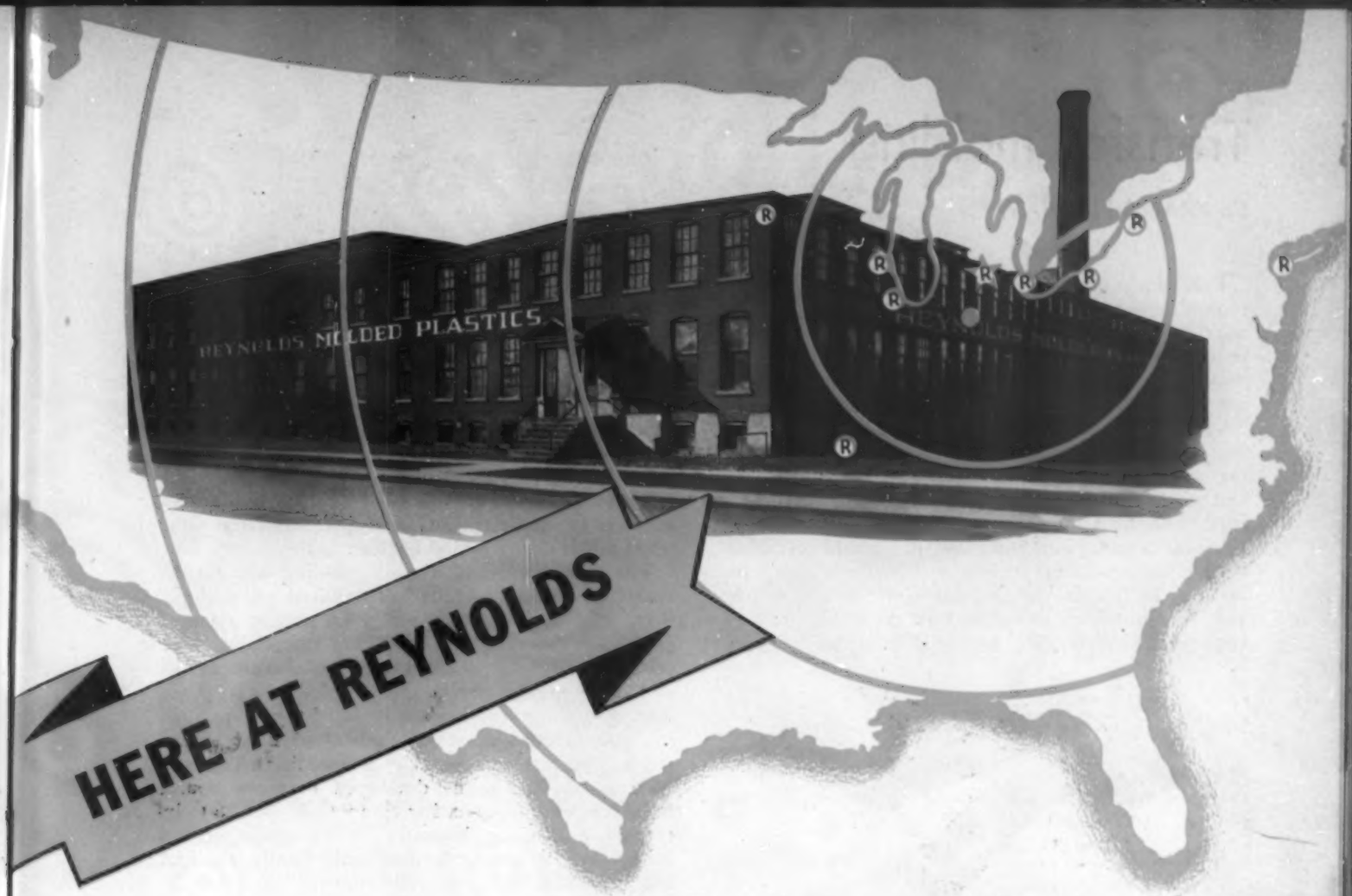
AS THE manufacturing of molded products found new outlets and production was increased, it became necessary to install in these factories time saving and economical systems. The method of filling the mold was slow and costly. The powdered material, consisting of a binder and filler such as woodflour or some phenolic resin, was carefully weighed and the charge then deposited in the mold. This was done by hand, consequently the accuracy of each charge and the time involved in preparing it depended entirely upon the attendant.

To obviate the necessity of weighing each charge, machines are now being used to compress the material into tablets or preforms. The preforms are made by feeding prepared granulations of the phenolic resin into the die of the machine and compressing it while in the die. This complete operation is entirely automatic and produces charges for the molds that are evenly compressed and equal in weight. Dies of various sizes and shapes are used in the machines, permitting the preforms to be as near the shape of the mold and finished product as possible. If the molded article is pierced with holes, has a beveled edge or some special contour, the preform is often similar.

It is much simpler to load the molds for hydraulic presses with a formed object than with powder, even in cases where it is necessary to use two or more preforms due to the size of the object to be molded. A preforming machine will produce from fifty to two hundred and fifty tablets per minute, depending on the size of the machine and the required tablet. In some instances, when only small articles are to be produced, the output can be stepped up with rotary machines to three or four hundred per minute.

The value of preforms has become so well recognized as a means to increase production and securing more uniform and better molded products, that many phenolic resin companies will now furnish their material in preforms of any shape and size specified.

* Arthur Colton Company.



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Transfer molding

BY FRANK H. SHAW*

Ever since molded plastic materials have gained recognition and acceptance by major industries, molders have been kept on their toes improving technique and overcoming difficulties that crop up in molding intricate shapes, particularly those with metal inserts which must be cast into plastic forms with micromatic precision. In many instances, metal bearings or threaded pins must be molded in place with not .001 in. variance, and channeled forms must be cast with definite control of wall thickness. The mere closing of the press often threw metal inserts out of line and bearings and pins were frequently collapsed during the molding operation. Definite control of wall thickness was next to impossible. Waste, which was a considerable item, had to be reckoned into the cost. However, as a result of extensive research

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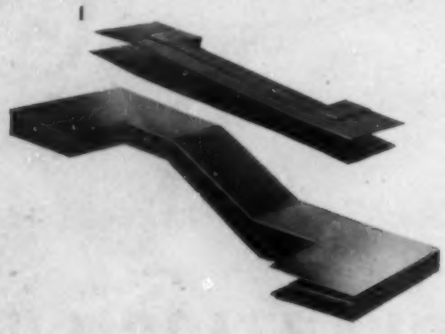

and experiment, these difficulties have been overcome to an appreciable extent by the development of extruded plastics or transfer molding.

The principal difference between transfer molding and conventional molding is in the nature of the mold itself. It has a separate heating chamber for plasticizing the thermo-setting material and is connected with the mold proper only by tiny openings, or gates through which the plasticized substance flows until the mold is completely filled. Transfer molding, compared to the conventional method is gentle in action. The plasticized material flows into the tightly closed mold without shock which eliminates the danger of collapsing delicate parts or disturbing their position, yet holds them firmly in place as the casting cools and becomes hard. Definite control of wall thickness is possible in every casting.

Practically no fins appear on objects cast by transfer molding. The gates are too small to allow more of the plasticized material to pass than is required to fill the mold. The cull, or overcharge remains in the heating chamber and finishing is reduced to a minimum. A tiny burr at each gate is quickly removed with a sand wheel and all evidence vanishes in polishing. Abrasive action on the mold is considerably lessened, assuring greater accuracy of castings from the same set of molds over a period of time.

The development of transfer molding was not accomplished over night. It has required years of patient trial and effort to reach its present state of perfection. Before phenolics, many compounds were grouped under the general heading of thermo-plastics and were molded for a great variety of purposes. Thermo-settings by no means replaced thermo-plastics, but they opened up a new school of thought and started the first real headway in molding technique. New molds had to be developed to accommodate these harder thermo-setting compounds and costs increased. Increasing demands for uncommon shapes forced costs to mount further until, finally, the idea was conceived to attempt to transfer the hard dry powders into plastic or semi-plastic state for extrusion. With the successful working out of the process came new possibilities of molding intricate parts which previously had been shunned because of limitations and difficulties imposed by orthodox methods.

* Shaw Insulator Co.

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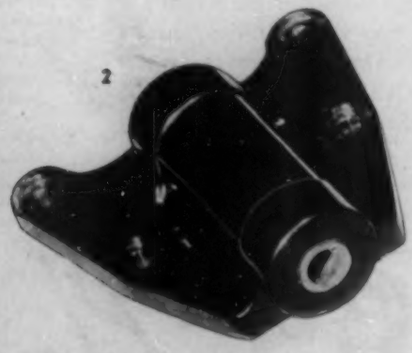

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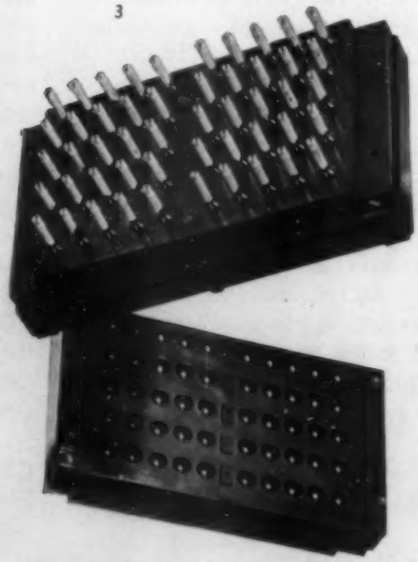

1. Bus bars, of impregnated canvas and phenolics, come from the transfer molds with no ragged fins. 2. Shick razor bearing molded by transfer. 3. Western Union turret panel has inserts molded in place with practically no variance in height

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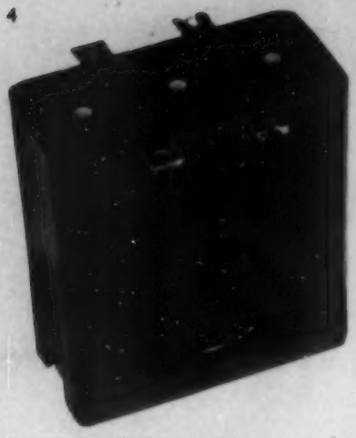


4. Coil box cover for telephone set showing tiny gates where plasticized material enters the transfer mold

Delicate inserts became possible with no danger of collapsing and wall thickness control became definite for the first time.

This technique has been refined to permit casting many hitherto impossible pieces. One-piece plastic bottles of any shape may be produced and lined with certain specified metal if required. A glass bottle may be put into a mold and given a plastic covering of the same contour. Toilet floats may be copper lined to last forever. Water cannot penetrate to the seams because the outer ball is cast in one piece instead of being cemented together. Thermos jugs, which are subjected to the action of moisture between the

5

5. Noise section of respirator with tapering channel and controlled wall thickness made possible through transfer molding. Also lead filled X-Ray tube shield with threaded metal fitting an integral part

thermos-unit and the outer shell, may now be cast in one piece and copper lined for permanent service. Copper lined tubing can be extruded in required lengths, being impervious to moisture and insulated against heat or cold. Plastic valves may be cast with metal valve-seat and closing ball already in place. Glass chemical daubers, which were formerly cemented into their handles, are now cast in one operation without danger of breaking the glass in casting and without cement for acids or chemicals to eat away.

Electrical equipment combining plastics with fragile materials may be cast without injury. This was impossible to do by the old method. Short wave insulation required the additional use of porcelain or glass for greater insulating quality than plastics alone possess. Either glass or porcelain inserts may be molded in place by the transfer method of molding.

Canvas or other impact resisting material is frequently used as a strengthening agent. It is so thoroughly mixed with the material itself that it does not permit free removal of fins from the finished object and ragged edges naturally follow. Transfer molding permits canvas or impact materials to be molded free from troublesome fins without sacrifice in strength and with superior finish.

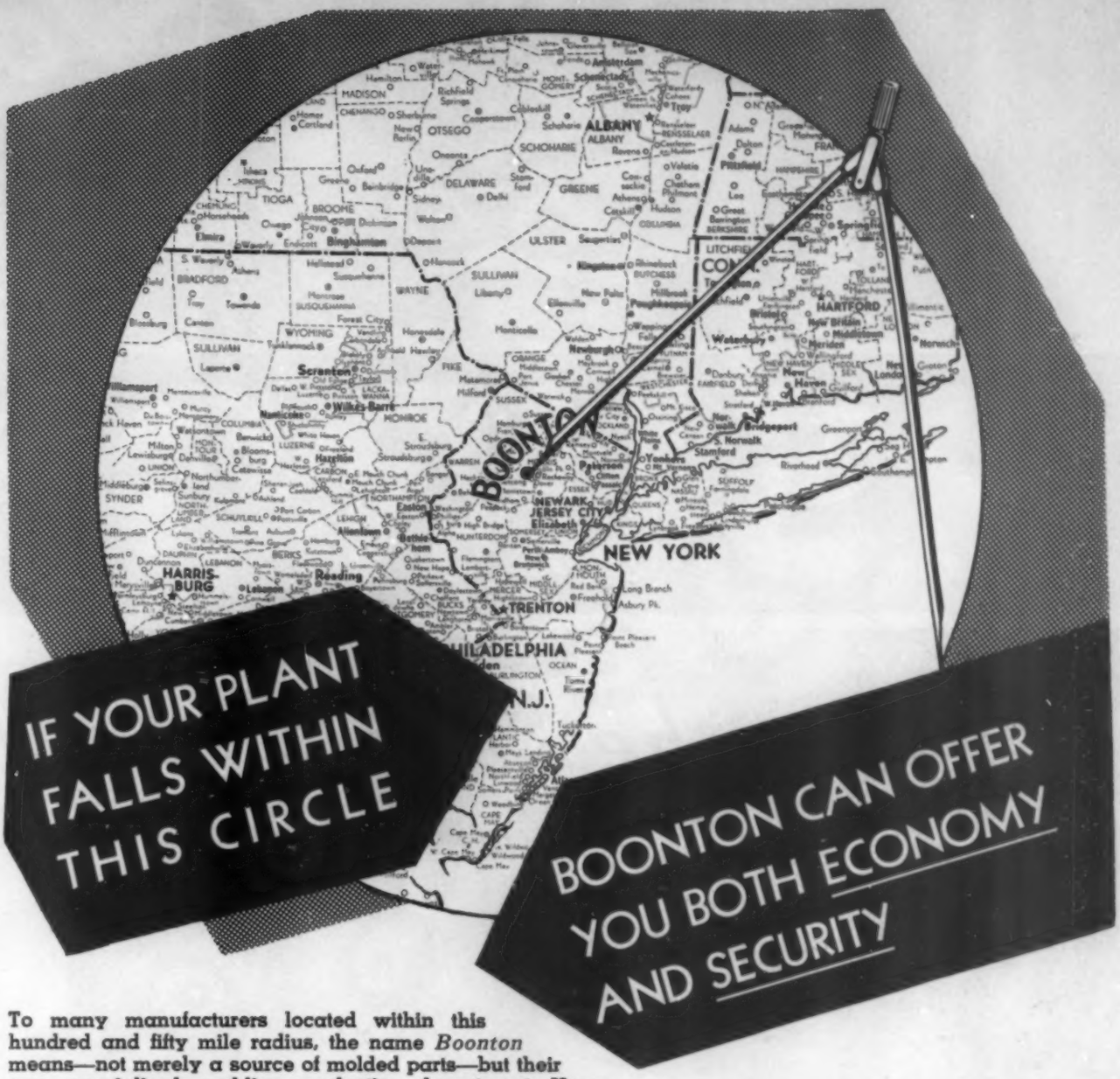
Pencil tubes with spiral thread for metal arbor perfectly centered are made by this transfer process with no variation of wall thickness and without fins. Points at the end of each tube indicate where the thermo-setting compound entered the tightly closed mold. Millions of these pencils have been made during the past few years with negligible spoilage. Lead filled shields for X-ray tubes are molded in one operation with threaded metal fitting properly and securely placed. They are uniform in size and no mold marks appear on the surface.

It is impossible to mold parts of the Schick Dry Shaver by any other method than transfer because delicate cams and shafts necessary to its accurate operation must be molded with precision. Conventional methods of molding would collapse these inserts or throw them out of alignment and render them useless. The Schick bearing has a hardened steel tube inside which invariably cracked under the old method, yet is perfectly centered and remains undamaged in transfer molding.

The Western Union turret panel has fifty accurately machined inserts of phosphor bronze costing six cents each. They must be set into the finished casting with no greater variance than .001 in. in height. If one of these bronze inserts is collapsed in molding there is an immediate loss of three dollars in material alone. None of them can be salvaged. This made casting by the old method costly, indeed, because they were frequently collapsed. Transfer molding has reduced this waste to almost nothing. The inserts are placed in the mold by hand and covered by protecting sleeves which allow a free flow of plastic material without danger of moving the parts.

Tiny files and screw drivers come from transfer molds with perfectly insulated handles cast as an integral part. There is no cement to work loose and allow the handles to slip off or turn. Hollow handles for use with hardware may be metal lined or cast from impact resisting materials and because of their homogeneous construction their finish is permanent. Two color castings of unit construction are made possible without cementing. Panels of one color may be cast into boxes of another color. Window signs may have a background of one color and letters of another. Inlays or any composite arrangement of colored plastics are made available without danger of intermixing or separating.

It doesn't require much imagination to see what this development of transfer molding means to the future of industrial molding. Nothing is impossible. The field is wide open to make use of plastics in ways never before dreamed of. Manufacturers faced with special manufacturing problems may be benefited through plastics which by transfer molding are made available for uses entirely new.



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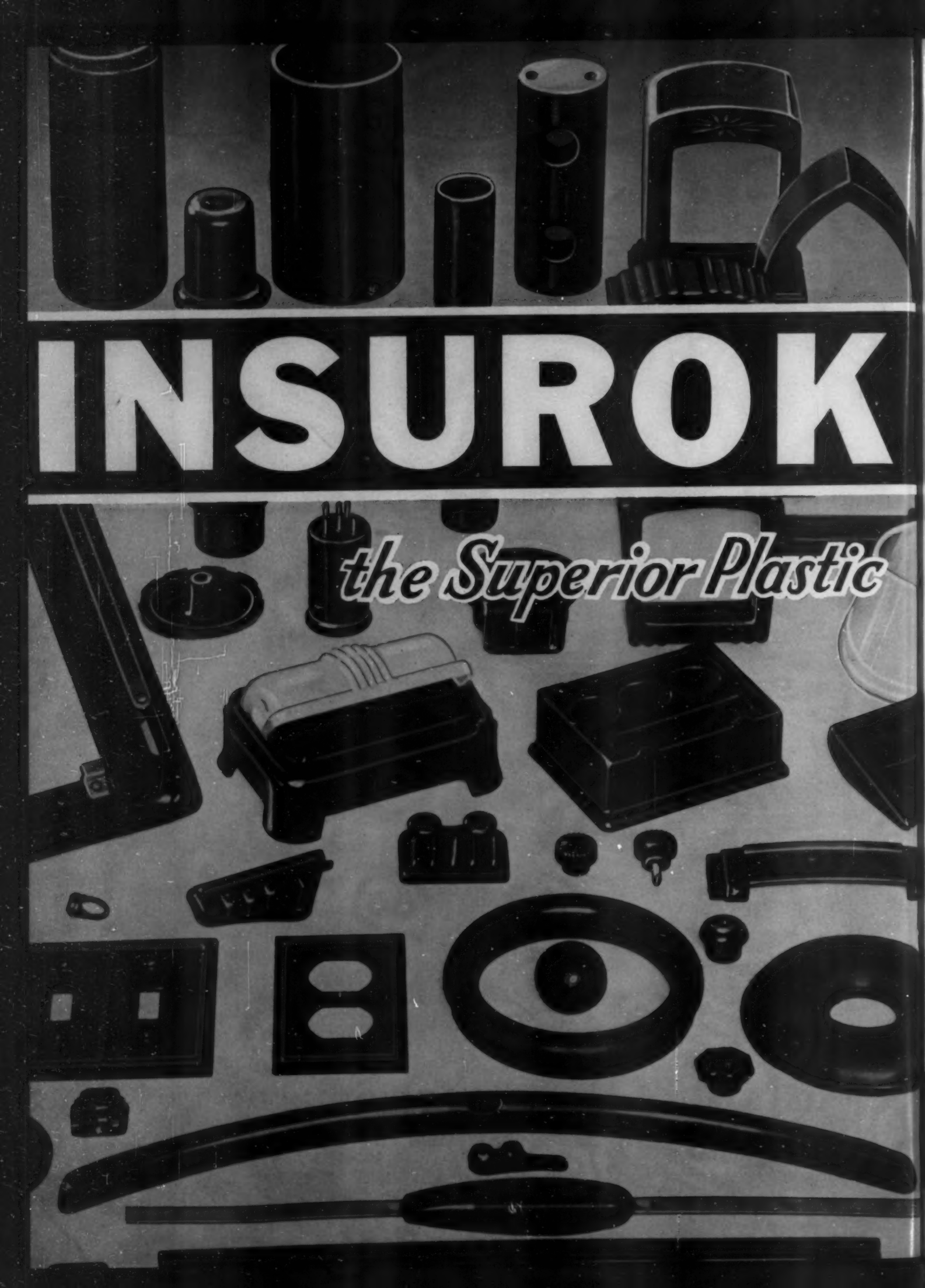
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Self-tapping and metallic drive screws

BY S. S. KAHN*

IN THESE days of keen competition, manufacturers realize they must carefully investigate every material and method going into the makeup of their product, with an eye to cost. If the unit can be assembled at lower cost and be equal in appearance and mechanical strength to that produced by the superseded method, the proposed method is worthy of thorough investigation.

In the fabrication of devices made of plastic materials, there are two methods of making fastenings that the engineer and designer should consider in the initial design conception; (1) metal inserts molded into the material, a method which originated with the birth of the plastic industry and (2) hardened self-tapping screws, the more recent fastening devices which are frequently found to effect savings in assembly costs.

Increased production and the resultant economies are usually predicated on large initial expenditures for new machines, jigs, dies, and fixtures. With this concept in mind, it is evident that the first thought of the prospective user of self-tapping screws will be in the form of the question—Will the use of these devices necessitate extensive and costly changes in my present manufacturing "set-up"? The answer to this question is as follows: The adoption of self-tapping screws does not entail additional expense or overhead because of the fact that there are no new methods to be perfected where training and skill on the part of the operator is required and furthermore, the adoption of these unique and labor-saving attaching devices does not require additional outlay for new equipment.

In this connection, we quote in part from a paper by a prominent engineer of naval aircraft construction, which follows:

"What is perhaps most startling at first glance is the fact that these self-tapping screws have been able to accomplish assembly economies in industries to whom all the opportunities of mass production and distribution of initial tooling costs over thousands of units a day were available. One prominent automobile body builder saved over $150,000 through their use during the first year. Yet their use takes the same percentage of economy on a single unit per day as it does on volume production."

Before going into detail relative to the numerous and diversified applications, where self-tapping screws have been utilized in the fabrication of devices made of various kinds of plastics, it should be stated that these screws are furnished in two types, one is self-

* Parker-Kalon Corporation

Left—Part of a permanent-wave machine assembled with hardened self-tapping screws. Below—Various plastic items in which self-tapping screws have contributed to economical assembly

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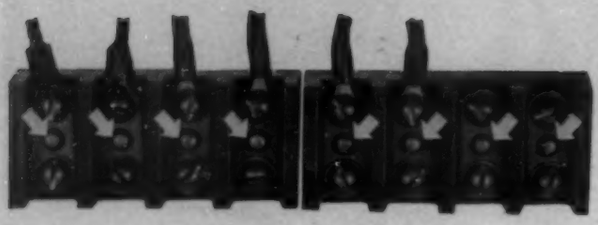

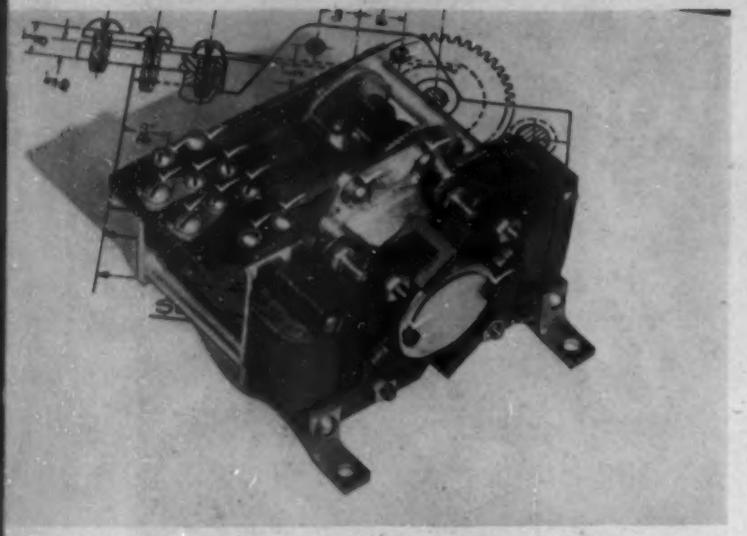

Above—Drive screws are used for fastening these metal terminals to phenolic blocks. Below—An electric timer using self-tapping screws (the removable kind). (Photos, courtesy Parker-Kalon)

tapping, the other is a metallic drive screw. The self-tapping screw is also furnished with a hex head which has been found advantageous in speeding up production, as a hex head facilitates driving the screw by means of a power driven screw driver.

In applying the two forms of screws, the self-tapping type is turned into a hole of the proper diameter in the same manner as the wood screw is driven into very hard wood in which a lead hole usually has to be provided, or as a machine screw is turned into a tapped hole. There is this advantage however, over a machine screw in a tapped hole, that the self-tapping screw forms the interior thread, thus obtaining a precision fit where every thread is in contact with the material and the load is therefore evenly distributed over the number of threads that are engaged. This is the main reason why self-tapping screws do not loosen under vibration or strains incidental to service. Parts that are fastened with this type of screw can be removed and replaced without impairing the security of the fastening.

The metallic drive screws are used for making permanent fastenings only. They are driven in with a hammer or press into holes, drilled or molded in the material. As they cannot be readily removed, they are recommended only for the assembly of parts that do not have to be disassembled for servicing or repair.

Tests made in the laboratories of the College of Engineering, New York University and Columbia University have shown that the holding power of self-tapping screws under tension and sheer loads is greater than machine screws in brass inserts. These tests have been verified by the Engineering Departments of many manufacturers who have carefully investigated the mechanical characteristics of such screws before putting them into their products.

Some of the advantages accomplished through the use of self-tapping screws in the fabrication of devices made of plastic materials are outlined below:

1—Elimination of the operation of molding brass inserts into the material.

2—Increased production of the die.

3—Uniformity of holding power (knurled brass inserts vary in holding power.)

4—Self-tapping screws make stronger fastenings than machine screws in tapped holes. This characteristic may be accounted for by the fact that these screws have greater pitch than machine screws which leaves more material between the thread convolutions.

5—The use of self-tapping screws when considered in the initial stages of the preparation of the design, will often lead to refinements which will improve the appearance of the device in addition to the savings effected in the cost of production, over brass inserts or other methods.

6—Elimination of tapping operations and "rejects" due to improperly tapped threads and crossed threads.

What has been stated with reference to the advantages of the self-tapping form of screw, also applies to the metallic drive screw used for making permanent fastenings. The drive screw functions in a different manner than the self-tapping screw. When it is hammered or pressed into place, the hardened spiral thread cuts into the material like a tap. The unthreaded portion or pilot, at the tip, holds the screw in place before it is driven in and also guides it so it will go in straight. Furthermore, the diameter of the pilot being somewhat larger than the root diameter of the screw, and slightly smaller than the outside diameter, the material that is displaced when the screw is hammered in, is forced between the thread and the pilot thus anchoring the fastening at the base. These screws make fastenings that are stronger and hold better than those made with machine screws, and other methods of fastening. Once driven in, they cannot be easily removed. Because of this, they are recommended only for assemblies that do not have to be disassembled. Like the self-tapping screws, they eliminate tapping operations, saving the cost of taps, maintenance of tapping equipment and losses due to scrapped parts resulting from mistapped and crossed threads.

In the foregoing we have attempted to acquaint you with the mechanical characteristics and some of the advantages obtainable through the use of self-tapping screws. Assuming that we are now more or less familiar with the self-tapping screw as a fastening device, let us make a little field survey to show what is being accomplished by manufacturers using plastic materials. The illustrations and captions will suggest many applications somewhat similar in character where the self-tapping screws can be applied to advantage and where economy is bound to result.

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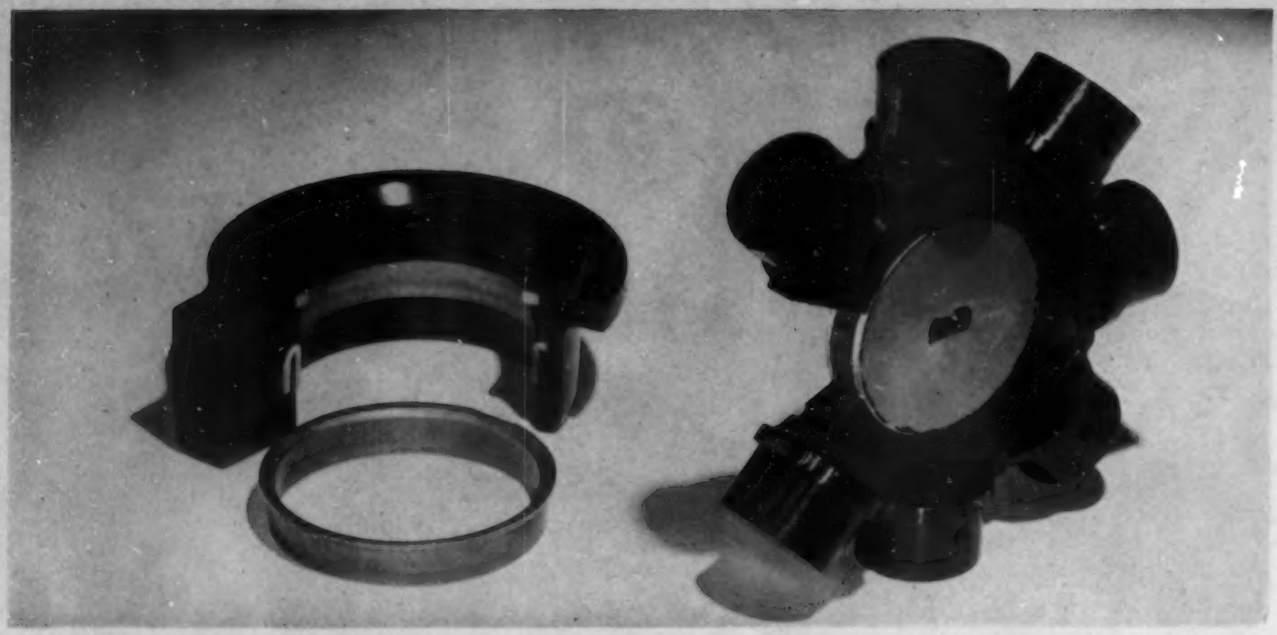


Molded parts, cut away to show the manner in which inserts become an integral part

Inserts for molding

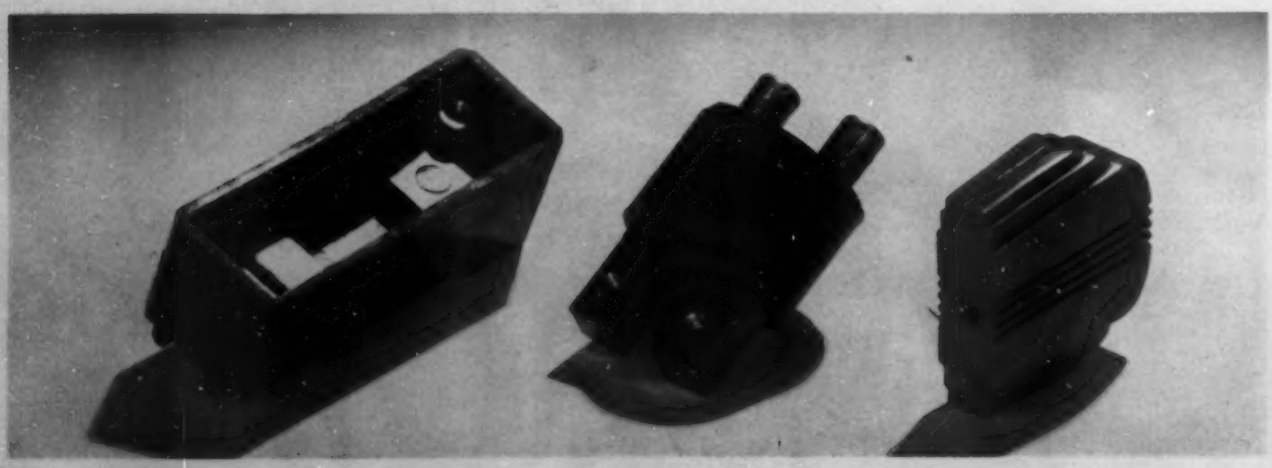
BY PAUL TIETZ*

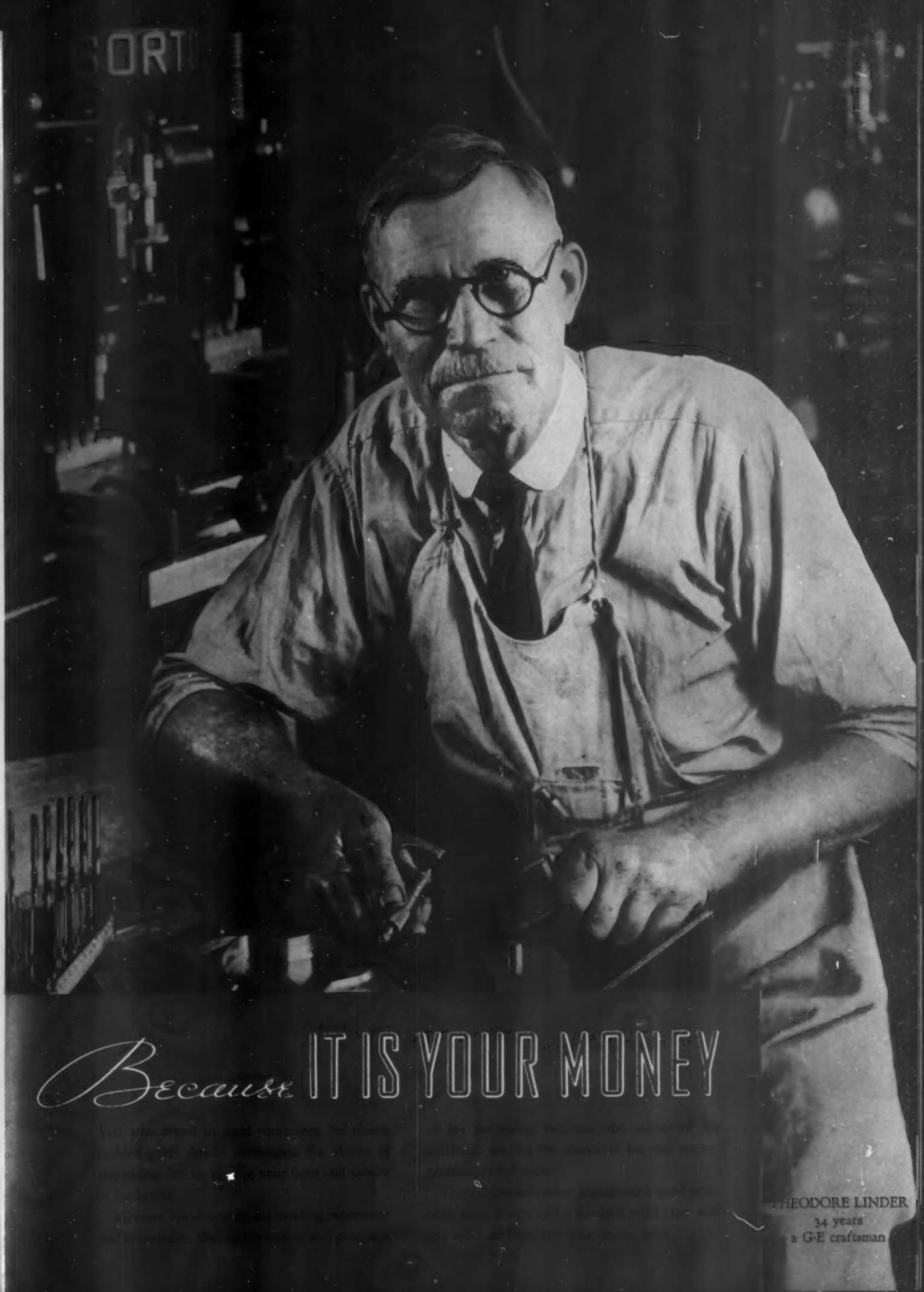
INSERTS in molded parts can be of many materials such as metal, fibre, wood, paper and rubber. It is possible to readily incorporate them with molding materials, during the molding operation. By using inserts, assemblies can be made easier, less expensive and stronger. Whenever possible, inserts should be positioned vertically in the bottom of the mold as it facilitates the molding. They can be placed on top of the mold but care must be exercised to hold the inserts to close tolerances so that they can be placed in position by a slight drive fit.

It is possible to mold inserts horizontally. However, they should be as short as possible and in cases of long inserts, be supported at two points. This is absolutely necessary in pressure molding. In injection molding of acetate materials, metal cases can be covered readily when placed in a horizontal position. Plating such as nickel, chrome, cadmium, etc. will not be affected during the molding operation. Care should be taken to eliminate removal of excess flash from plated inserts

* The Richardson Company

Terminal box and other parts in which inserts become firmly placed in molding

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GENERAL ELECTRIC invites you to consider its ability as a dependable source for molds and molded parts. If you were to do so:

You would find a group of engineers with the knowledge and experience that can be secured only through years of successful application of plastics.

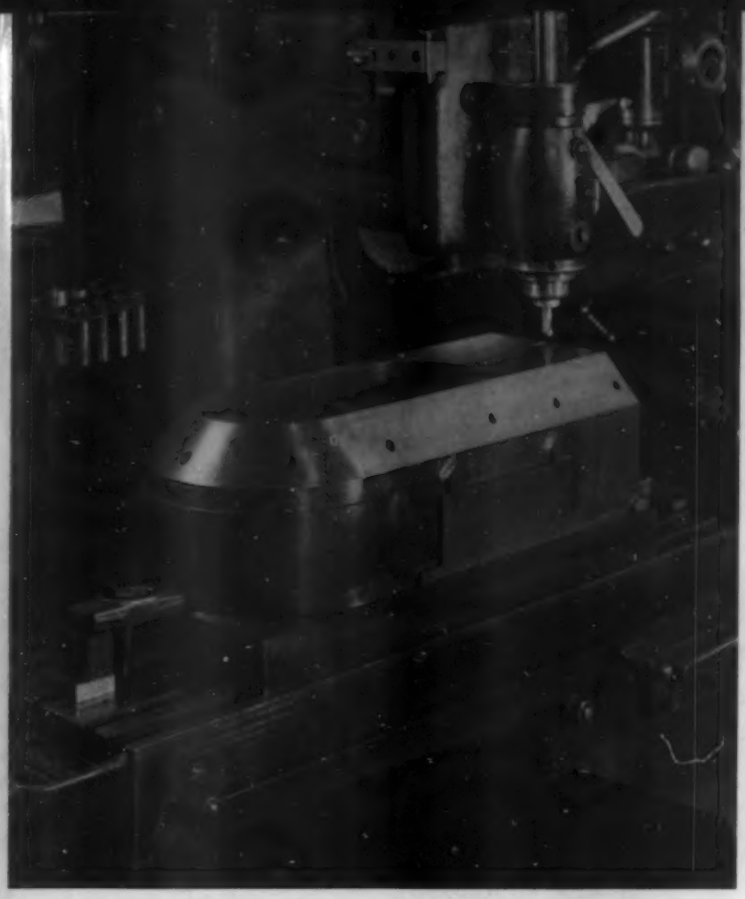
You would learn that General Electric maintains the largest and most modern tool room under the supervision of able men.

You would notice the skillfulness of G-E designers and craftsmen whose work is apparent in the development of large-unit molding and in the plastic parts molded by G-E for Toledo Scale, Hobart Mfg. Co., Wakefield Brass Co., Enterprise Mfg. Co., RCA Mfg. Co., The Miller Co., and many other large manufacturers.

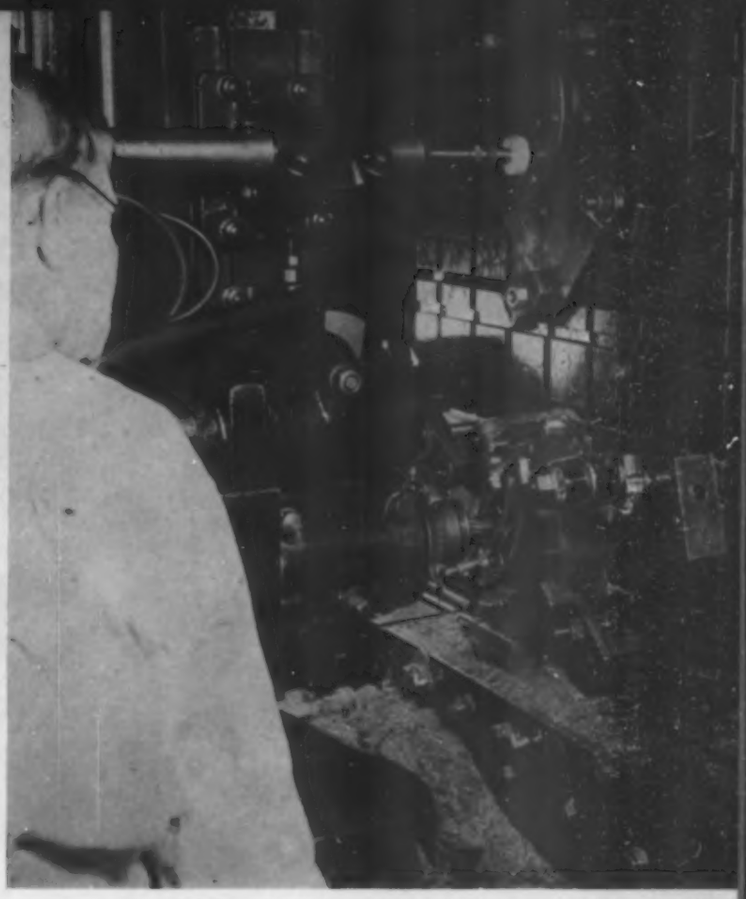
You would find many definite indications which would show that General Electric, in its twenty-six years of molding, has learned the importance and technique of good mold making and has realized that successful molding is accomplished only by giving the customer the best his money can buy in molds and molded parts.

When you invest in new mold equipment and you want to be sure that your finished molded part will meet all specifications, call on General Electric—its facilities, personnel and knowledge is your assurance of correct mold design, accurate dimensions, a smooth fine finish, economical production and personal supervision. In other words, you can be sure of a 100% dividend in benefits on your investment.

THE MOLD IS THE BACKBONE OF YOUR MOLDED PART—



Plunger part of the mold for the Hobart Coffee Mill housing



Modern machines and experienced hands assure accurate molds

A General Electric press for large-unit molding

A small section of General Electric's plastics tool room

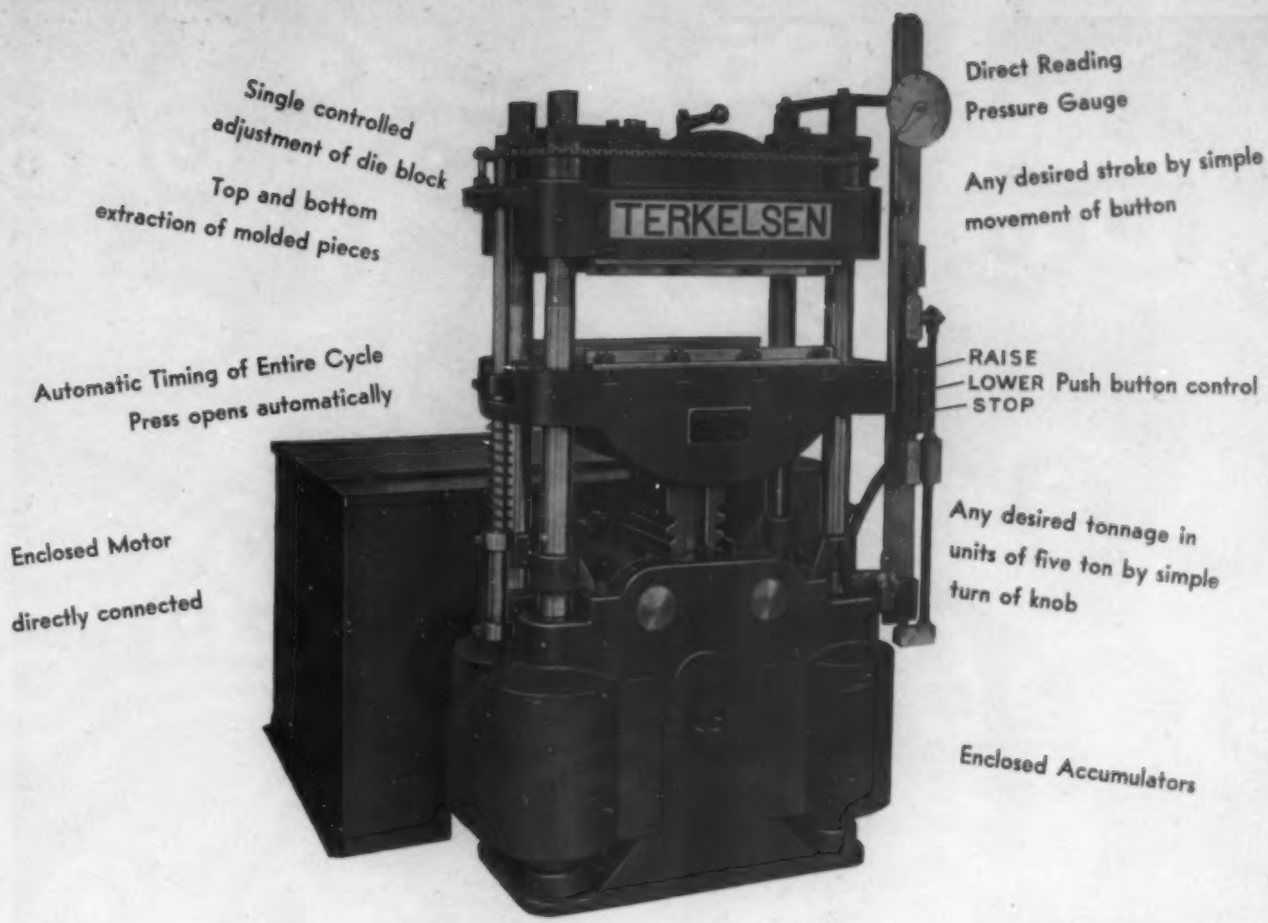
GENERAL ELECTRIC

Plastics

ON IT DEPENDS THE SUCCESS OR FAILURE OF THE PART

And General Electric will continue to lead in plastics research, development, engineering and quality

APPLIANCE AND MERCHANDISE DEPT., GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN.



TYPE E-1—MODEL 100

CONTROLLED MOLDING

A Complete Molding Unit
No Auxiliary Equipment

Terkelsen presses are complete molding machines designed expressly for present day high production at low costs of molded pieces. The press pictured is not an adaptation but our dream realization after twenty-nine years' experience in the plastic molding field. It has been possible in our own molding plant through cooperation with material manufacturers to obtain results that cannot be equalled with any other equipment insofar as quality production or production costs are concerned.

Noiseless In Operation
Nothing to Leak or Spill

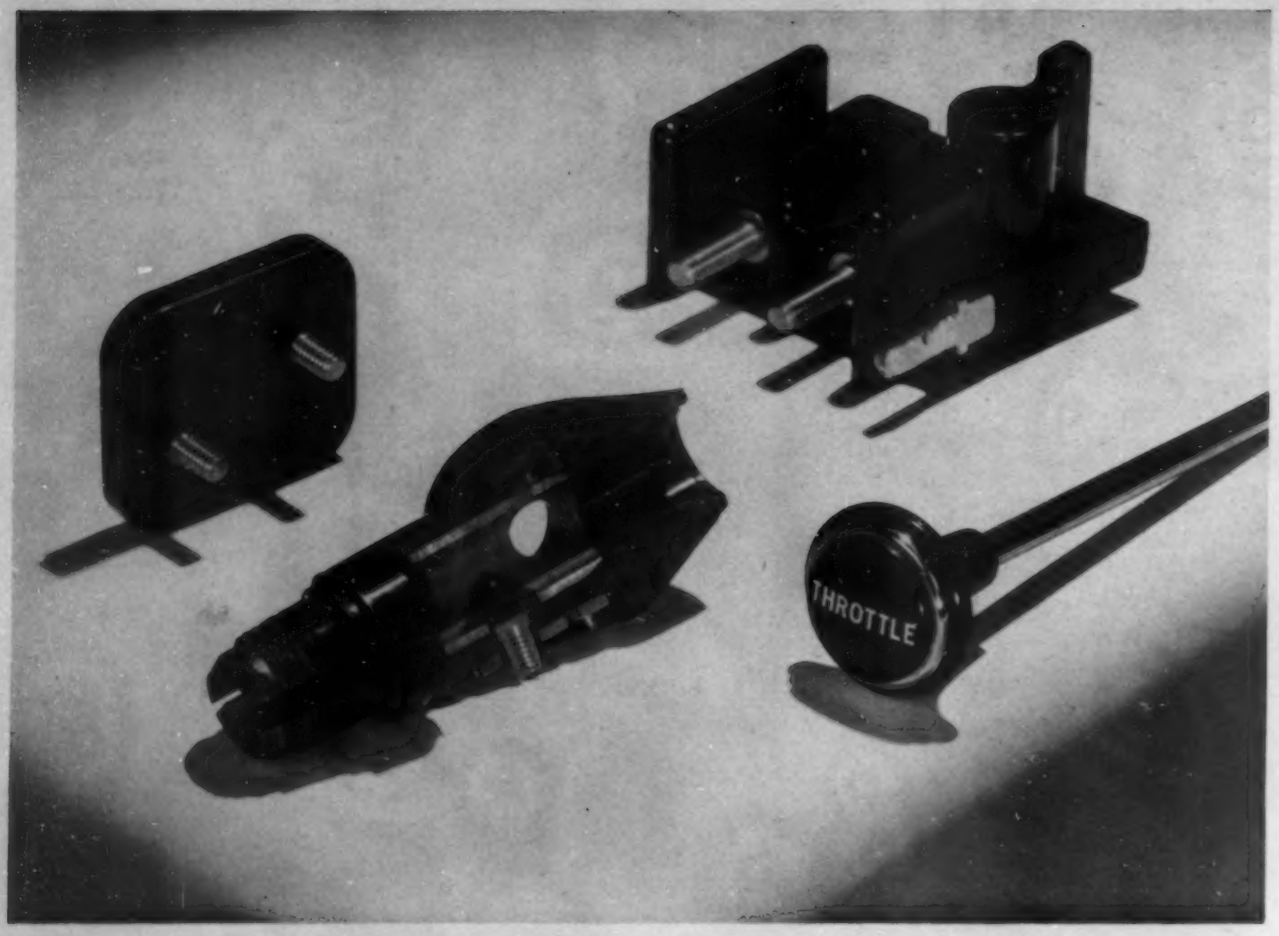
Phenolic colors or Ureas are produced absolutely uniformly with the use of our automatic timing device. This device opens the press at any predetermined period and the result is real uniformity of molded pieces. Colors will not vary as curing time remains constant. Gassing operation is entirely controlled.

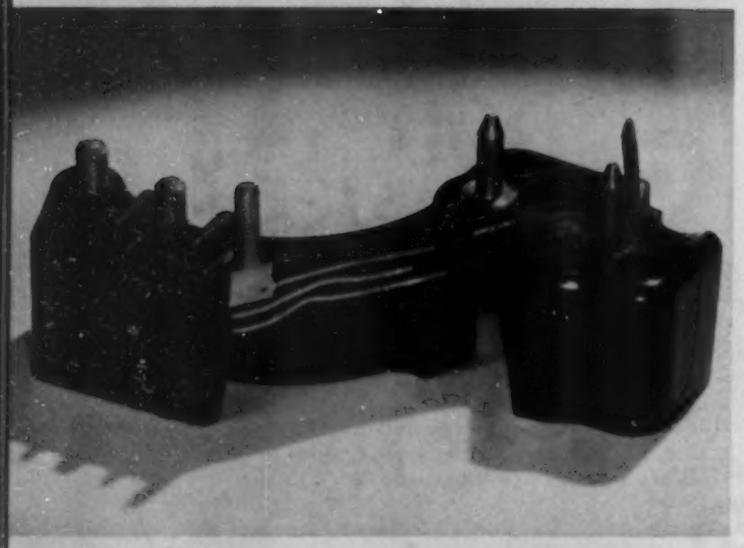
write

TERKELSEN

322 A Street Boston, Mass.

For full information on this most modern and up-to-date molding equipment.



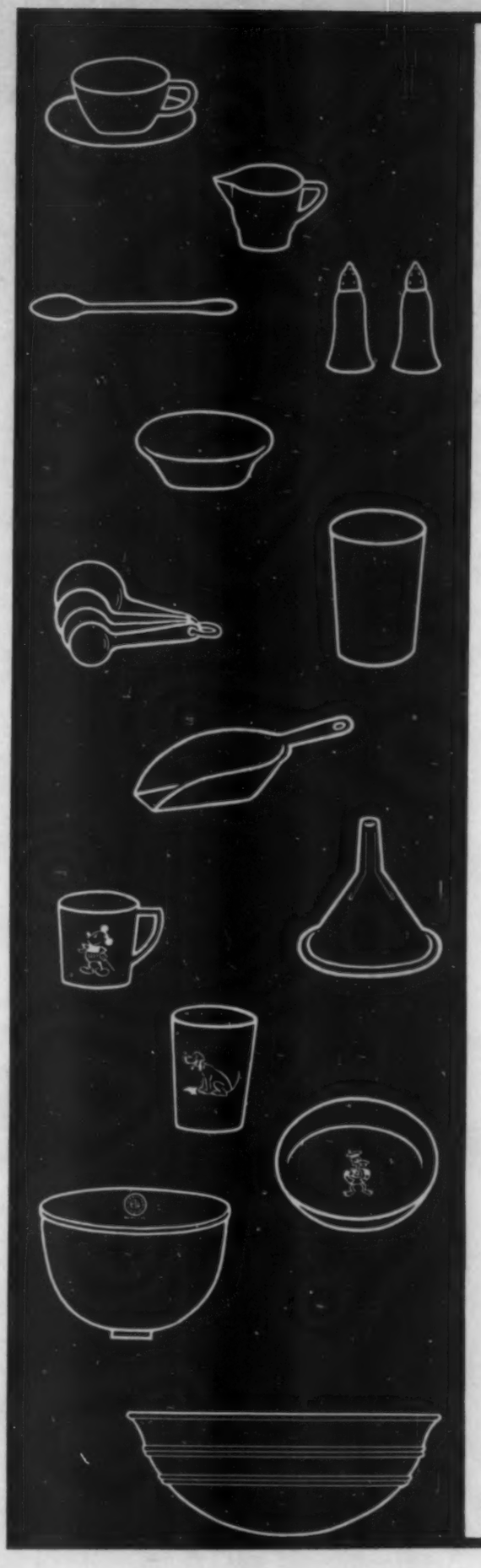


Top—Shows a variety of uses of inserts placed in molding. The shaft at the right is molded into the throttle and becomes immovable. Below—Shows conductors molded integrally with the part yet are perfectly insulated

so that surface plating will not be removed by the mechanical operation. When metal parts produced by the screw machine method are employed, they should be knurled with a diamond knurl or if square and hexagon stock is used, a groove undercut is necessary and all this should be of sufficient depth to insure a firm embedding in the molded material.

Large copper bus bar wire contacts have been molded in position. However, in these instances in order to compensate for difference in coefficients of the two materials, it has been found desirable to coat the metal parts with a pure rubber before molding. Whenever an arc is apt to occur on an electrical contact and a path is formed in molding material, it is advisable to use a fibre insert to break the arc. Also, if flat stampings for bus contacts are to be molded in position, sheet fibre placed between the metal prevents any short circuit of the contact. On commutators you can mold a center core of molding material around a copper outside ring by merely designing the holding lugs of the ring so they embed themselves properly. Here is also recommended the use of low shrinking materials.

Wood is used largely where a light weight piece is required and a heavy section of molding material would be replaced thereby reducing cost of finished pieces. The wood must be of kiln dry stock and contain no moisture. Paper, either plain or preferably impregnated with the resin, has been molded to give additional strength to finished pieces, also in some cases for exterior finishes. Metal stampings are embedded in the molding material for greater strength electrical connections which must be insulated and free from moisture absorption. *(Cont. on page 221)*



WORLD-FAMOUS NAMES OF MOLDED PLASTIC WARE

HEMCOWARE . . .

Children's dishes, luncheon sets, campers' kits, kitchen ware.

BEETLEWARE . . .

Premiums, toy dishes, novelty lamps, boxes.

SAFETYWARE . . .

Special children's dishes, smokers' items, hardware, novelties.

MICKEY MOUSE . . .

Plastic dishes and toys with all famous Walt Disney characters. We are the exclusive licensees.

HEMCOLITE . . .

Plastic ware for lighting applications. Portable lamps, I.E.S.-approved bowls, reflectors for all lighting purposes.

■

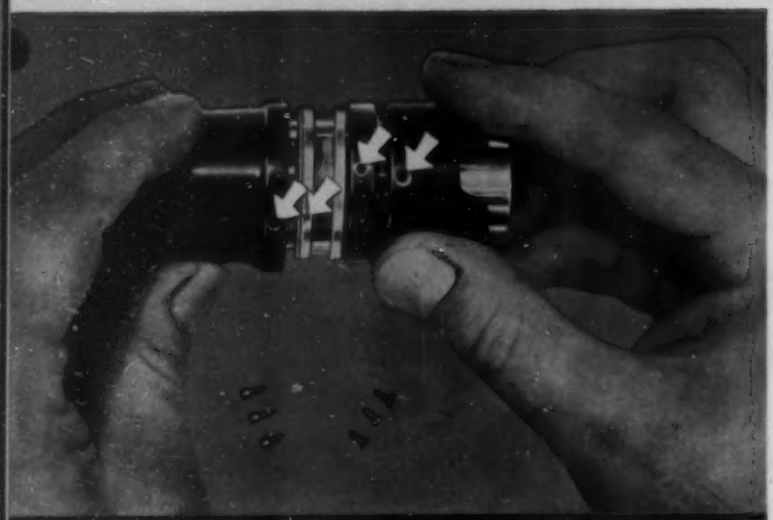
Products of

HEMCO PLASTICS DIVISION

THE BRYANT ELECTRIC CO.

BRIDGEPORT, CONNECTICUT

Stronger fastenings COST LESS . . .



PROOF that stronger fastenings can be made to plastic materials with Parker-Kalon Hardened Self-tapping Screws is found in unbiased tests by authorities. These unique Screws *hold more securely than the combination of a machine screw in a threaded insert,* and are far superior to a machine screw in a tapped thread.

Remember that! Then just consider that *it actually costs less* to make fastenings with Hardened Self-tapping Screws . . . less in both molding and assembly time and labor . . . less, even, in material expense. Scores of prominent molders, and manufacturers of all sorts of plastic products have demonstrated this.

No Simpler Way to Assemble Plastics

It is bound to cost less. You merely drive these Screws into a drilled or molded hole . . . a thread is formed in the material by the Screw as it goes in. It is simple and fast. There's no danger of stripped threads.

COMPARE with other methods: *To use threaded inserts and machine screws* means extra expense for inserts . . . often adds weight, takes up space, weakens assembly . . . slows-up and complicates molding. *To use machine screws in tapped holes* means an extra operation . . . weak threads that easily cross and tend to break down quickly . . . often involves

DIFFICULT Assemblies easily and securely made

1 Much trouble and expense is saved in fastening thin molded shell to aluminum, and a molded part to a molded ring on hair wave machine. To tap the tiny holes would mean tap breakage, rejects.

2 In fastening small contacts to molded microphone case, 30% spoilage of cases resulted from difficulty in tapping bottomed holes of ⅛" depth; also it was necessary to true the molded holes with a drill then tap and retap them. All this Self-tapping Screws eliminated, cut time and labor in half and also ended former trouble of loose contacts.

3 Saving of 2½ cents per unit made by eliminating insert in fastening receptacle to Bakelite base of microscope lamp.

4 By using Self-tapping Screws for fastening contacts and clips to a Tenite battery case, 50% of assembly time and labor was saved, 30% gained in production speed, countersinking of 3 contacts avoided, tapping in cramped space and stripped threads eliminated, fastening strength doubled.

5 Eight inserts eliminated with a good saving, plus assembly speed and security is result of using Self-tapping Screws for fastening contact assembly and a fibre cover to molded case of a battery-operated knife sharpener.

6 Tough problem solved in fastening molded ring into thin molded housing of a volume control. Rivets broke ring; the small taps required for machine screws broke. But Self-tapping Screws were perfect and cheaper to use.

It pays to consider **PARKER-KALON HARDENED**

SIMPLIFY molding and assembly

breakage of taps . . . often results in rejects due to stripped and crossed threads and mis-tapped holes. *To force machine screws or wood screws into unthreaded holes* means poor assemblies and returned merchandise . . . difficult work . . . excessive rejects.

To Learn What You Could Save have a Parker-Kalon Assembly Engineer make a study of your fastenings

If your product requires fastenings to any of the common plastic materials such as Bakelite, Durez, Tenite, Catalin, Celluloid; or to fibre, ebony-asbestos and the like, it will pay you to get full information about Parker-Kalon Hardened Self-tapping Screws. A Parker-Kalon Assembly Engineer will gladly make a study of your fastenings and point out all practicable opportunities for using these unique Screws to make better assemblies, at lower cost. Your invitation will bring him to assist you. He has nothing to sell. *Parker-Kalon Products are sold only through recognized distributors.*

*Parker-Kalon Hardened Self-tapping Screws are made in two types: Type "Z" — which is turned in with a screw driver and can be removed and reinserted repeatedly without destroying holding power; Type "U" — which is hammered in or otherwise forced in to make a permanent fastening. Both are available in a wide range of sizes with various styles of heads.

PARKER-KALON CORPORATION
Dept. P. 190 Varick St. New York, N.Y.

Examples of Economy in making SIMPLE assemblies

7 Makers of electrical timer figure 25% saving on fastenings of contact springs to Bakelite panel; also on assemblies of metal parts of the timer.

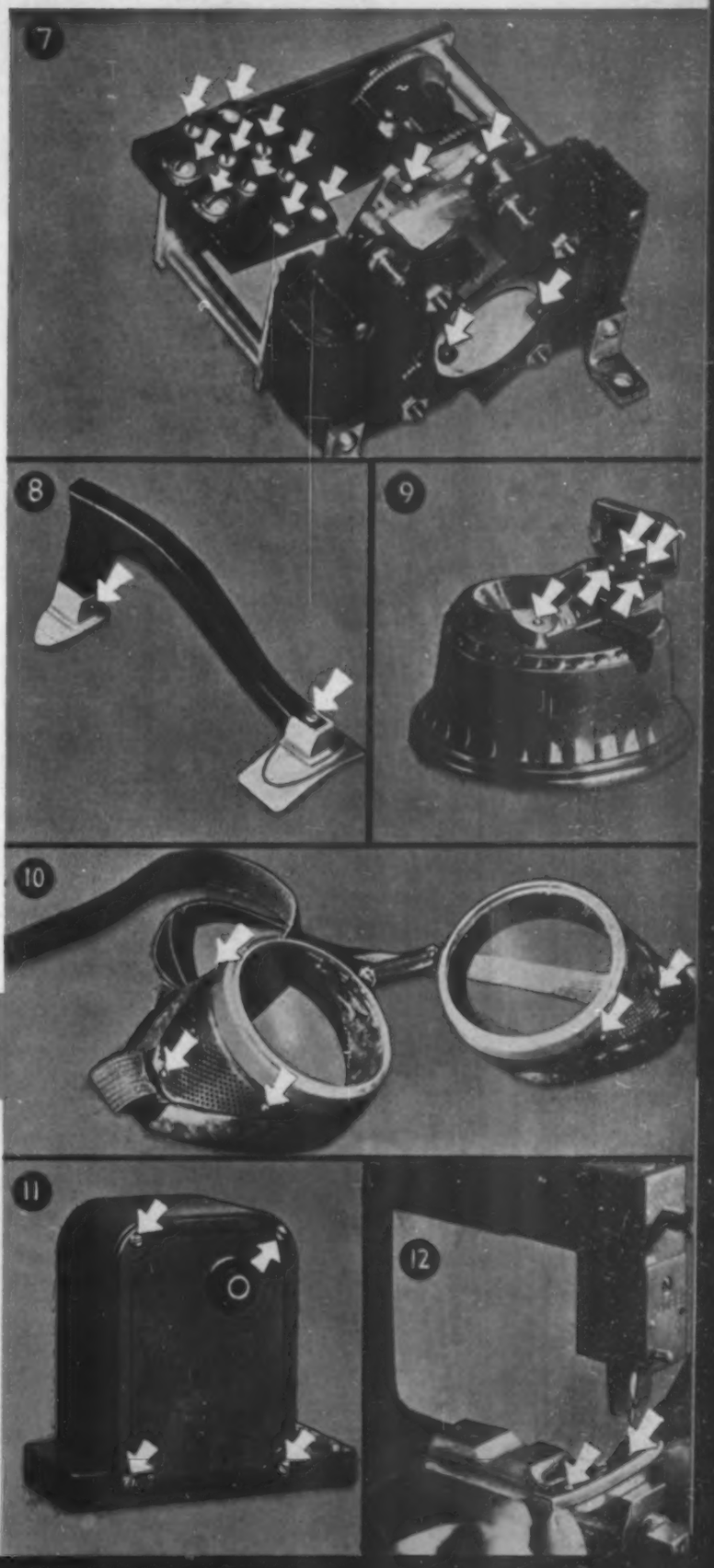
8 Utensil maker avoided a costly, insecure assembly by using Self-tapping Screws.

9 Molder of smoke set not only eliminated expensive inserts in attaching a hinge and cigarette rest, but also increased molding speed 30% and assembly rate 100%.

10 To attach metal screen to goggles of impact molding material, tiny but strong fastenings were required and obtained for less cost than imperfect ones.

11 Comparison of costs of alternative methods of fastening molded cover to molded condenser case showed the economy of Self-tapping Screws. Better results were also obtained.

12 After using machine screws, wood screws and rivets for fastening ornaments made of Celluloid, Catalin and similar materials to metal pocket-book frames and novelty jewelry, the maker tried Self-tapping Screws. Result—assembly costs cut 25%, production speeded up, returns from faulty merchandise reduced. Picture shows Type "U" Screws being press-driven, often an advantageous method.



SELF-TAPPING SCREWS *for Every Assembly*

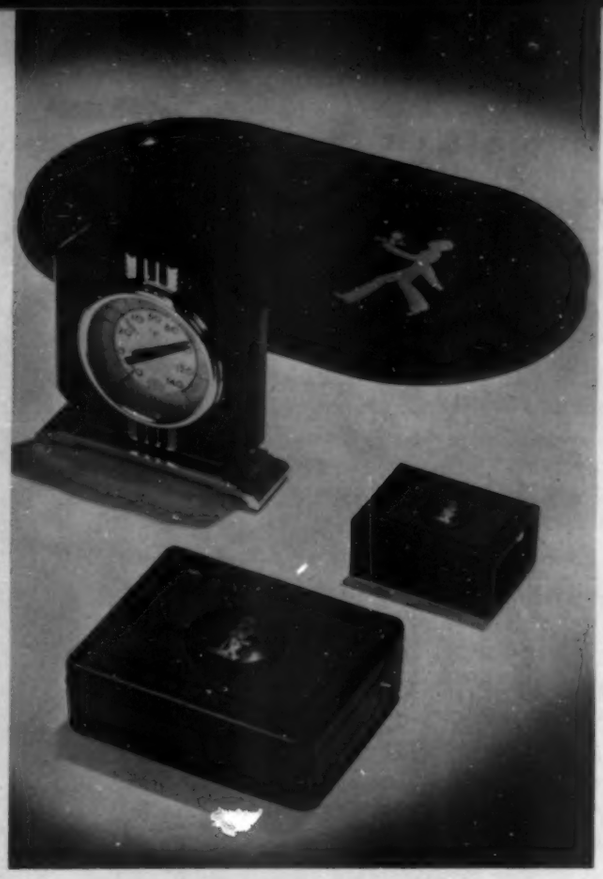
Inlays and overlays

BY EVE MAIN

THE combination of metal with plastics is a natural and compatible one, and the ease with which thin metal decorations may be applied to either molded or cast pieces suggests unlimited possibilities for individuality in design. Made of chrome plate, brass, copper, nickel silver, bronze and 14-carat gold, these metal decorations may be used as inlays applied during the molding operation when they become a composite part of the molded piece and also by pressing into cast resins which soften sufficiently with heat to allow the material to flow around the edge of the metal and make a flush inlay.

Used with molded pieces, inlays are held securely in place in the mold by two methods. Tiny pins may be locked into the bottom of the mold and small holes introduced into the design of the inlay into which the pins fit snugly, preventing the metal from slipping. The other method is to open the mold before the curing cycle takes place and while there still remains some flow in the material. The inlay is placed by hand and the mold reclosed after which the curing process continues. The choice of method depends upon the equipment and number of cavities being used.

Although not noticeable upon casual examination, these metal decorations have a slight bevel at the edge over which the plastic material flows locking the inlay in. Otherwise, when the plastic material cooled, there might be danger of it popping out. Inlays are etched economically and add but little to the cost of finished pieces. Prices are based, not on the intricateness of the pattern but on the actual square inch area of the design and the quantity desired. They range from



Metal inlays are used also to add interest to rather prosaic design

1 cent a square inch in large quantities to 2½ cents in smaller lots. There are few restrictions in the matter of design although the thicker the metal used, the less detail it is possible to reproduce. Some molders, however, feel it is essential to have greater strength in the decoration. Normally, metal in thickness of .005, .007, and .010 in. is used.

The same metal designs may be used as overlays by cementing them on after the piece is finished and usually .005 in. thickness of metal is used. Where overlays of brass or bronze are used it is necessary that they be lacquered to prevent tarnishing. Otherwise they might turn black after a short time. Chrome will remain bright indefinitely and nickel silver does not tarnish though it may dull a bit from constant use. In ordinary service these overlays never come off. The adhesives employed are not soluble in water or alcohol and would dissolve only in naphtha or gasoline and these two liquids are not likely to come in contact with the article in general use.

These thin metal decorations have been successfully combined with plastics for an extensive group of products. They make a most effective trim for dresserware. For this purpose, the inlay is composited between two layers of cellulose material so that it becomes a part of the plastic and the metal cannot be felt by running a finger over it. Initials and decorative motifs have been applied to toothbrush and razor handles, jewelry, gear shift knobs and fishing reels; the brewer's

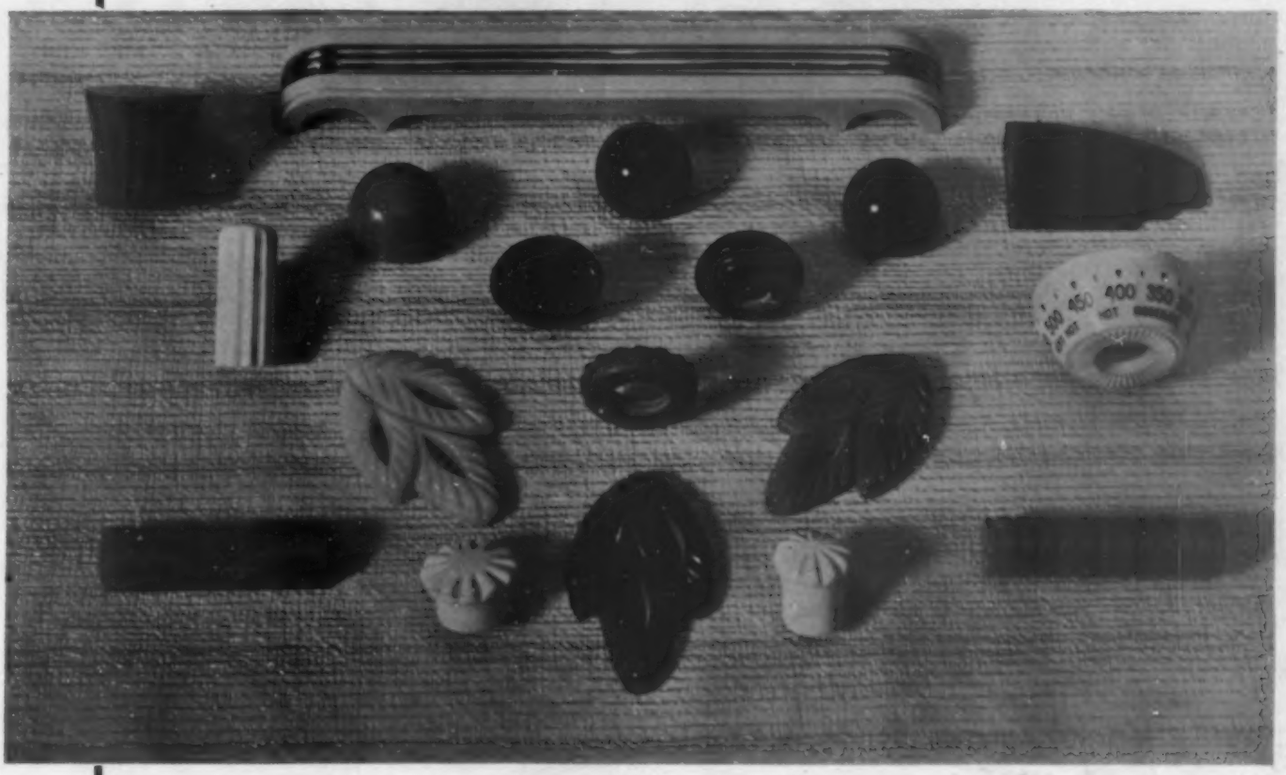
No sign is more permanent or readable than one of plastic with metal inlays. They are decorative as well as entirely practical

INTRODUCING

LEAROK

THE BUFFING COMPOUND WITH NO FREE GREASE

The Compound for Buffing Cut and Molded Plastics.



The Lea Mfg. Co. brings to the rapidly growing plastic industry the benefit of its many years experience in the manufacture and use of polishing and buffing compounds.

LEAROK, which is successfully used in other industries and is available in many grades (kind and size of abrasive), is particularly adaptable to giving cut and molded plastics any degree of polish desired. The fact that it has no "free grease" means that very little "packing up" and in many cases none at all occurs in the crevices or ornamentations. LEAROK is a clean-working, fast-cutting composition.

And another outstanding feature of LEAROK is that it can be tinted to match the color of the finished article and by so doing add to its lustre.

The accompanying photograph shows shapes cut and molded from plastics on which LEAROK is successfully used. Send us a sample of your work for our recommendation.

THE LEA MANUFACTURING CO.

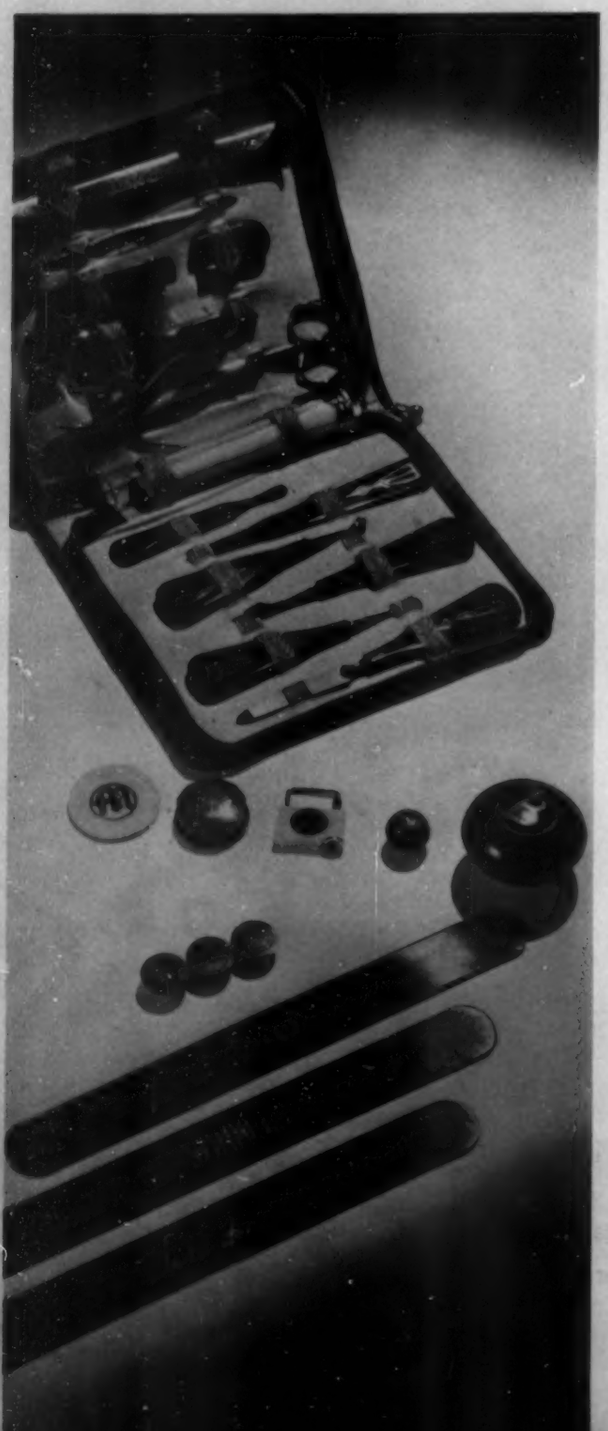
WATERBURY, CONN.

Canadian Agents: Lea Products Co., 686 Notre Dame St. West, Montreal, Canada

monogram appears on knobs for faucets on beer taps where the kind of beer must be designated, and molded bar combs, which have been used extensively, are decorated with the brewer's name in metal; window and counter signs both large and small gain distinction by the addition of a company name or insignia in bright metal, thermometers and a dentist's drill case are identified by their metal decoration; metal numbers are molded on tally balls for pool room use and poker chips are molded with metal initials on both sides by putting the metal inlay on the preformed pellet which, because the pellet almost conforms to the mold, assures the centering of the letter.

One molder inlays metal initials on small, flat round buttons of various colors, and three of these are used to complete a bar pin. The initialed buttons and pins are delivered to the retailer separately and a customer may choose the proper initials in the color she wants to match her ensemble, and these slide into a slot on the pin and are held in place by a nubble on the end.

Below is a variety of familiar objects in which inlays are used as a mark of decoration or identification



With a little imagination these metal decorations can be made to do a real job. For example, they are particularly adaptable to premium use where they may take the form of monograms, trade names, advertising slogans or other appropriate motifs. Suppose a manufacturer of molded ashtrays planned to sell them for premium use to a list of advertisers. The cost of cutting one advertiser's name and slogan into the mold and then blanking it out and recutting it for another, might prohibit the use of the item for this purpose. However, by using metal inlays for the decoration, the manufacturer is safe in offering his ashtrays to several premium users for after he finishes molding a lot with one insignia, his original mold is still intact and he can go ahead with a second order by simply buying another type of inlay without alteration of the mold. In this way, stock molds become even more interesting to small manufacturers who would perhaps not require the distinction of special molds for a product but who do wish to have their merchandise clearly identified.

Another molder may have a stock mold for faucet handles on which he wants to mark "hot" and "cold" without changing the mold or going to the expense of engraving the molded handles and wiping in with lacquer. By making use of metal inlays, he can run off 100 or 1,000,000 of each, using the same mold for both handles. After he has completed his run, the mold is still unbranded and he can go ahead and use it for handles marked "steam," "gas" or whatever he might have occasion to require.

This also can be applied to radio knobs. A molder with a stock knob might wish to put an insignia on it such as a four leaf clover or other motif. Instead of engraving the mold, metal inlays can be placed in it and the knobs run off. If afterwards, another radio manufacturer wanted to use the same style of knob, the molder could incorporate his insignia or other decoration without preparing a new mold or re-making the old one.

It is even possible to produce a series of plastic boxes that look entirely different yet come from the same mold. This can be accomplished by preparing a box mold with a perfectly plain cover, then taking advantage of the almost unlimited variety of colored plastic materials available, the molder might incorporate different metal inlays for different manufacturers using the same mold. He might use a coat of arms, a filigree or perhaps a simple border and run off any quantity desired and then proceed to turn out an entirely different looking box simply by changing the decoration with other inlays.

These are but a few of the many opportunities presented by the use of metal inlays and overlays but anyone with imagination and a sincere desire for individual and exclusive decorative effects in plastic products will find them worth talking about with their custom molder or fabricator.

Examples used to illustrate this article were loaned through the courtesy of Kurz-Kasch, Kayton Displays, The Burt Co., Catalin Corp., Panelyte Corp., Weston Elec. Co., Bakelite Corp., Colt's Patent Firearms Co., Henkel-Clauss, and the Probar Corp.

molders of plastics

AMERICAN INSULATOR CORPORATION

NEW FREEDOM, PA.

AMERICAN INSULATOR CORPORATION

Factory and General Office

NEW FREEDOM, PENNA.

SALES AND SERVICE OFFICES

BUFFALO, N. Y.	338 Huntington Ave.
CHATTANOOGA, TENN.	804 Provident Building
CHICAGO, ILL.	11 S. Desplaines St.
CLEVELAND, OHIO	415 Union Building
DETROIT, MICH.	614 Stephenson Building
LOS ANGELES, CALIF.	3834 Third Avenue
NEW ENGLAND, STRATFORD, CONN.	115 Allyndale Drive
NEW YORK, N. Y.	101 Park Avenue, Room 1523
PHILADELPHIA, PA.	401 N. Broad Street
ST. LOUIS, MO.	4866 Farlin Ave.
ST. PAUL, MINN.	611 Ryan Building

CUSTOM MOLDS AND STOCK MOLDS

This country has at last awakened to the fact that there really is such a thing as a Plastic Industry and that its products have a definite position and widely increasing usefulness and acceptance in the general scheme of things.

For almost twenty years the American Insulator Corporation has been molding practically every conceivable form of acceptable molding compounds. During this period we have had the honor of supplying large quantities of molded parts to a very great number of companies of national prominence covering very widely diversified fields of activity. We have served them, we hope, to their entire satisfaction.

Our activities are confined almost exclusively to what is generally termed "Custom Molding": That is we produce from specially designed tools individual parts in accordance with our customers' definite specifications. We always have and always will scrupulously refrain from in any way competing with our customers.

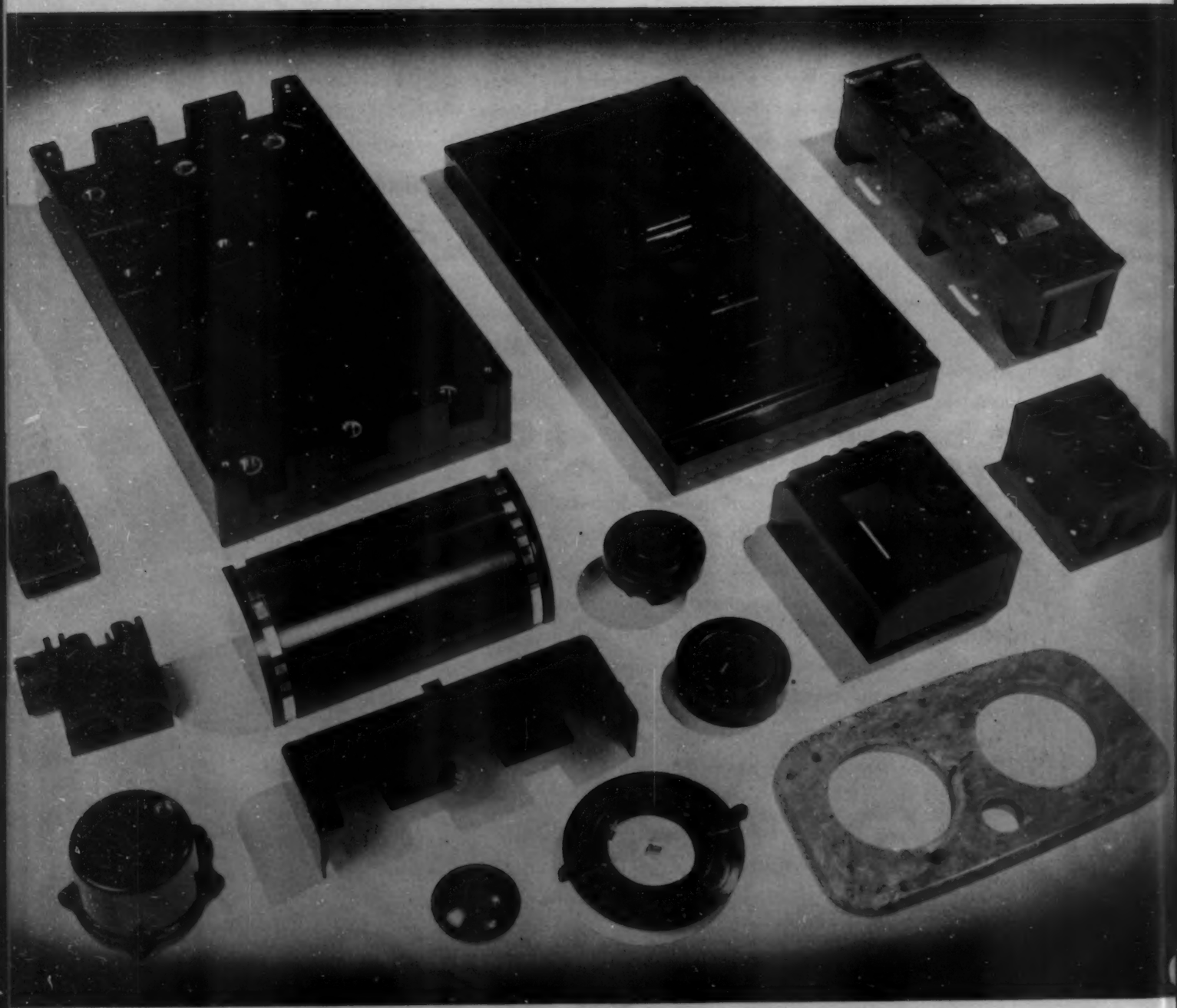
Over the years with the construction of several thousand individual molds, we are now, however, in a position to supply without fitting up charge or tool cost a considerable number of what are known as "Stock Parts." In this catalogue, we are endeavoring to show with a reasonable degree of clearness and accuracy such parts as can be supplied from what are known, for want of a better name, our "Stock Molds."

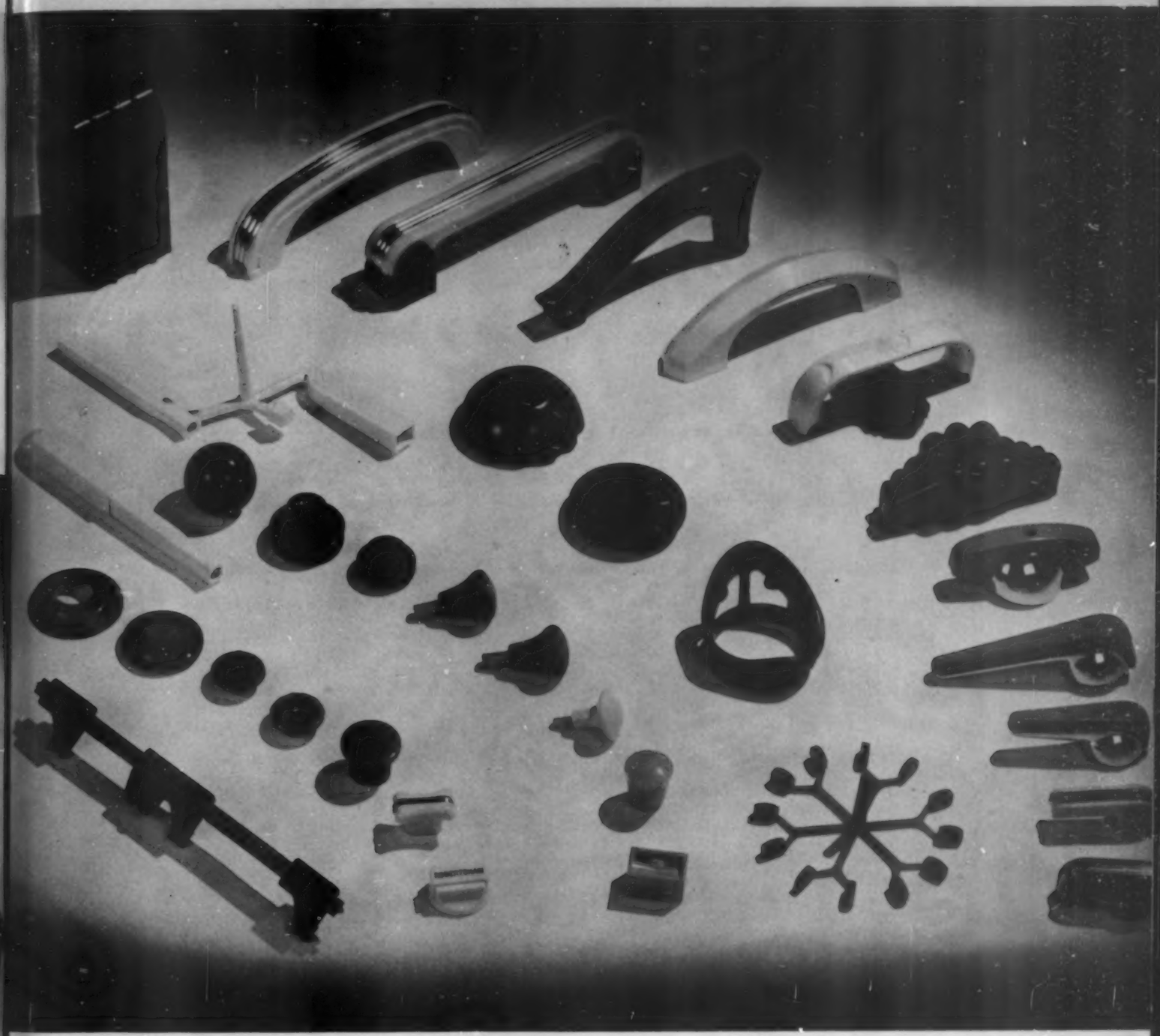
Photographs and drawings of these stock parts have been reproduced and catalogued in a small booklet which is now available to users and prospective users of molded plastics.

This catalogue has been prepared in a loose leaf form so that it may at all times, be kept up to date with further information as to new stock parts as they become available, and full data on new molding materials that will without question of doubt appear in the near future and with amazingly increasing scope of application.

Our sales, engineering and design facilities are always at your disposal. We consider it a privilege to be in a position to offer such services and trust that you will not hesitate to avail yourselves of them.

We take great pride in making every conceivable effort to effect a complete, efficient and satisfactory service in molded plastic parts of the highest quality.





Reproductions of photographs on these two pages show parts from a few of the several thousand molds which have been designed, built and successfully operated at our plant in New Freedom. Note the diversity of products and observe the range of parts from the simplest small moldings to parts of extremely intricate design, where by the very nature of the part extreme accuracy is demanded both in mold construction and in processing of the product.

AMERICAN INSULATOR CORPORATION

WHAT IS A CUSTOM MOLDER

The custom molder is prepared to serve the customer:

By offering expert advice on the practicability of contemplated designs.

By advising as to the best materials for specific requirements, if these requirements fall within the limitations of the molded plastic field, also to advise if they do not.

By reviewing contemplated design of articles, devices or structures and advise wherein molded plastics can be substituted for the usual materials, to improve the whole from the standpoint of appearance, reduction of weight, lower thermal-conductivity, dielectric, sound reduction, cost reduction, or in consideration of the many special properties to be found in the great variety of materials in the rapidly broadening field of molded plastics.

By keeping the customer informed of the development of new materials or new technique for handling the now well-known materials to the end that advantage may be taken of the sales value that is realized from style leadership, since it must be recognized that applications which are now accepted as distinctively molded plastics' own, is no criterion of adaptions that must be considered for the immediate future as better molding technique develops properties that may adequately meet requirements that are now inadequately filled by better known material.

So, whether you are building a simple gadget for the home or store, a machine for industrial purposes or an architectural structure, we ask that you take our salesmen and engineers into your confidence and permit them to secure for you the benefit of our many years of experience in handling plastic molding materials. Since the inception of the industry, our Engineering and Research staff have been abreast of developments of these materials in their application to all their many

fields of use including electrical, automotive, stove, refrigerator, radio, packaging, building trades, and many other home and transportation industries.

Your preliminary designs are held in strictest confidence by our entire staff. They are as safe from unauthorized disclosure as if we were a department of your plant, and indeed we wish to give you the kind of cooperation that will, in effect, make us your plastic molding department.

In the following pages, we show by means of photographs and drawings parts for which we have stock molds.

Parts from these molds can be supplied as shown without mold charge to the customer.

Often slight modifications of even these designs can be made at relatively small mold charges.

We have endeavored to make this listing as complete as possible at the moment.

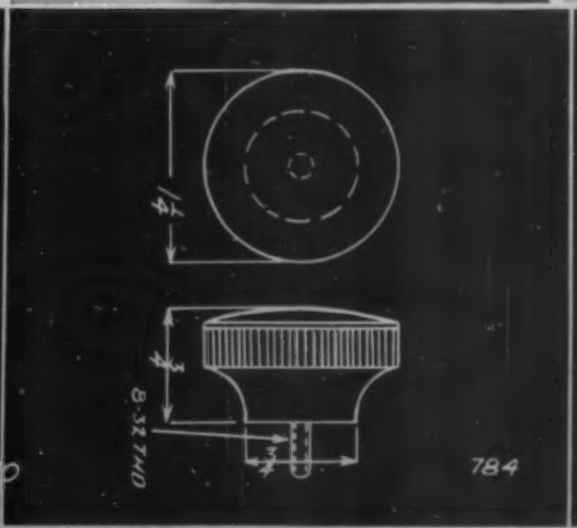
When additional molds become available we shall supply pages to be added to our catalog.

A LINE WILL BRING OUR CATALOG

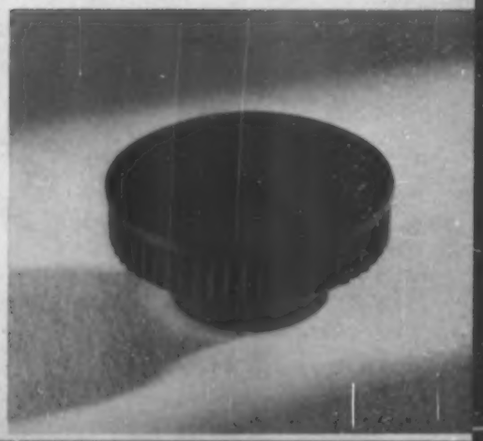
plastic parts from STOCK MOLDS

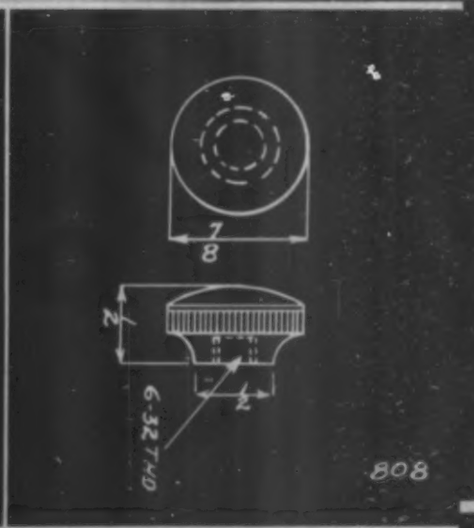
Knob
770
Cold molded composition

Knob
784
Cold molded composition

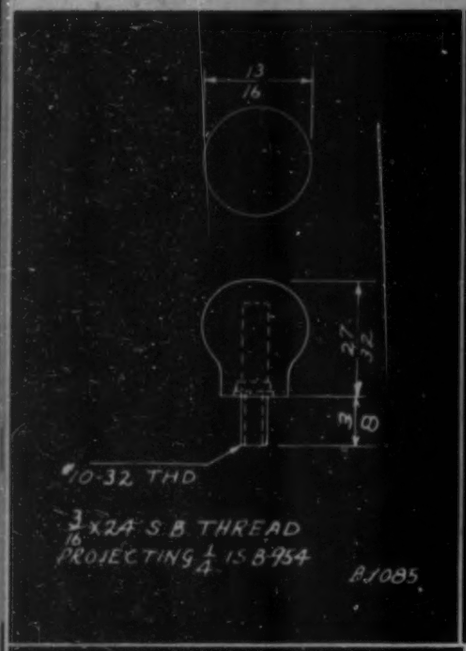


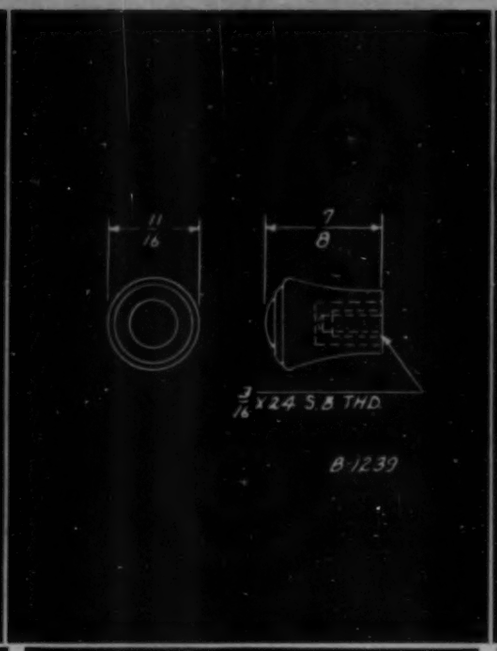
Knob
808
Cold molded composition

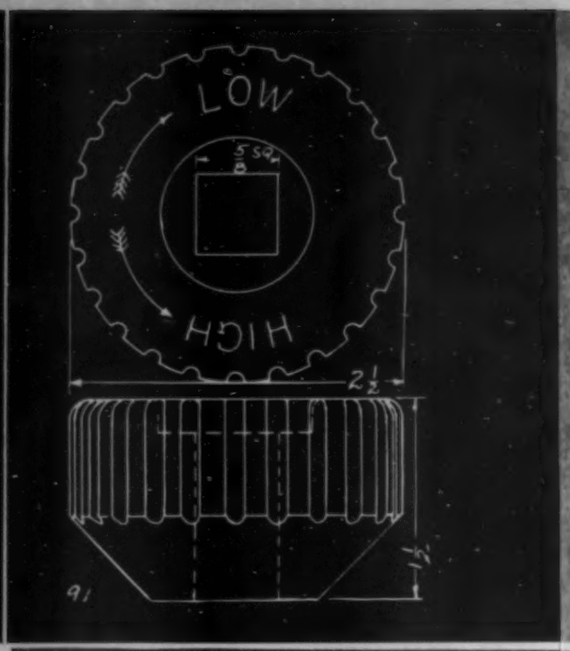


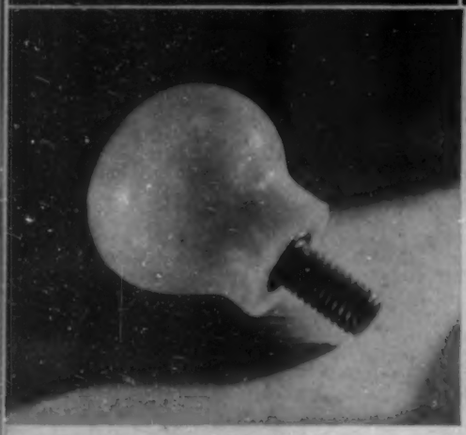


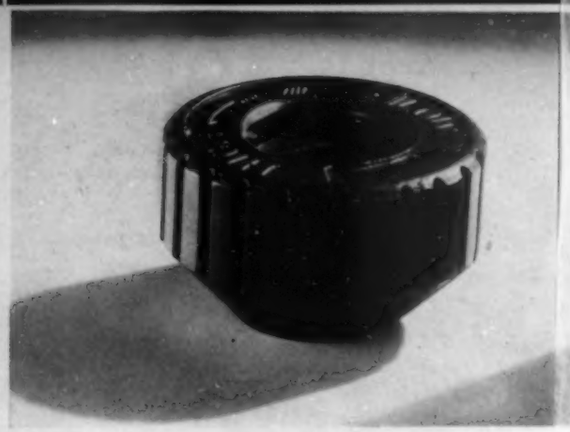
AMERICAN INSULATOR CORPORATION











Knob

B1085 & B954

Phenolic, urea or cellulose acetate

Knob

B1239

Phenolic, urea or cellulose acetate

B795

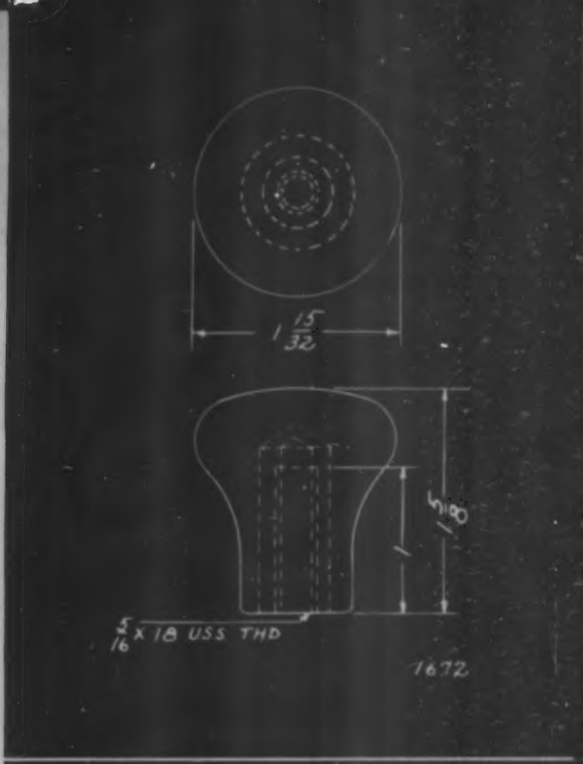
Same as above but with plain top like B526 on page 164

Regulator handle

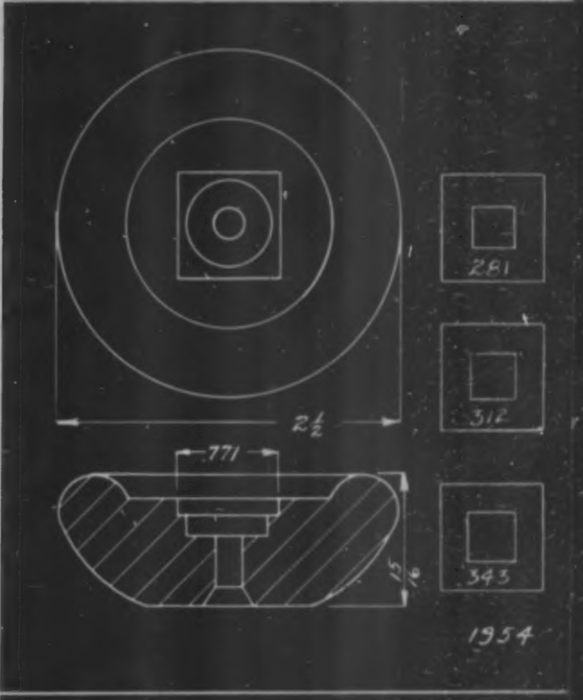
91

Cold molded composition

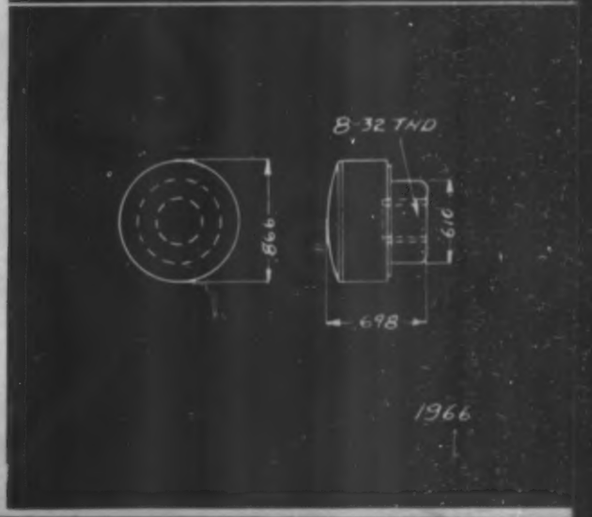
Lever handle
1672
Cold molded composition

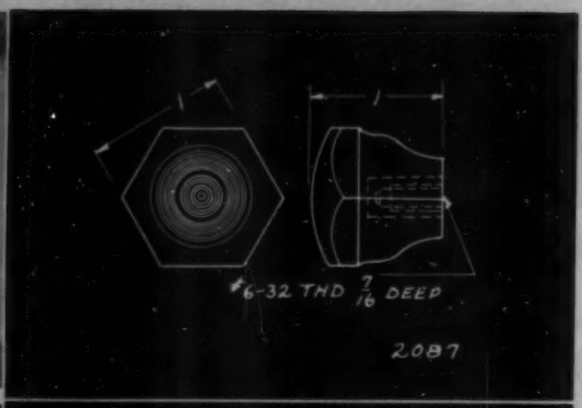


Valve handle
1954
Cold molded composition
Any of three inserts may be used

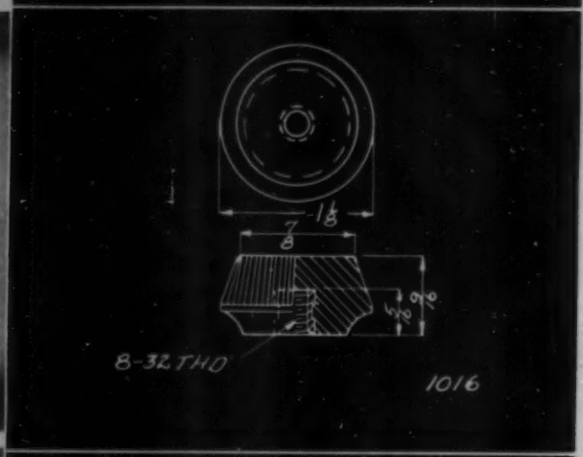


Knob
1966
Cold molded composition

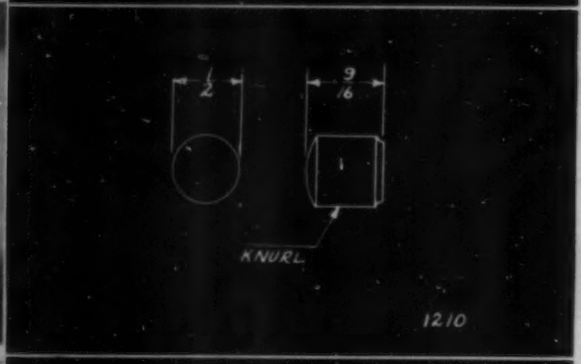




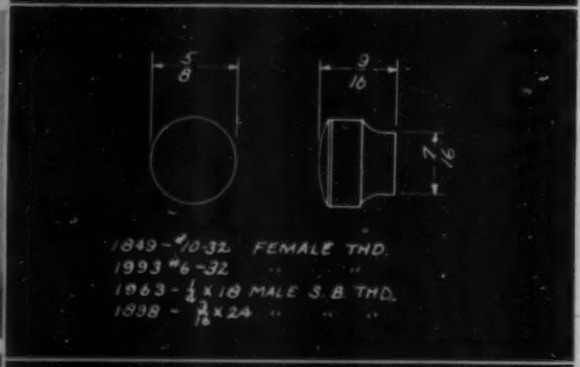
Knob
2087
Cold molded composition



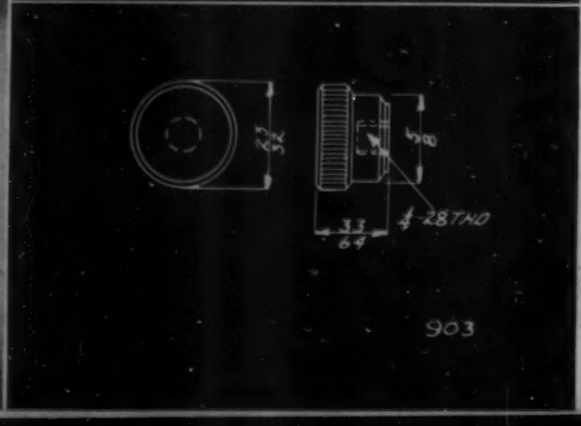
Knob
1016
Cold molded composition



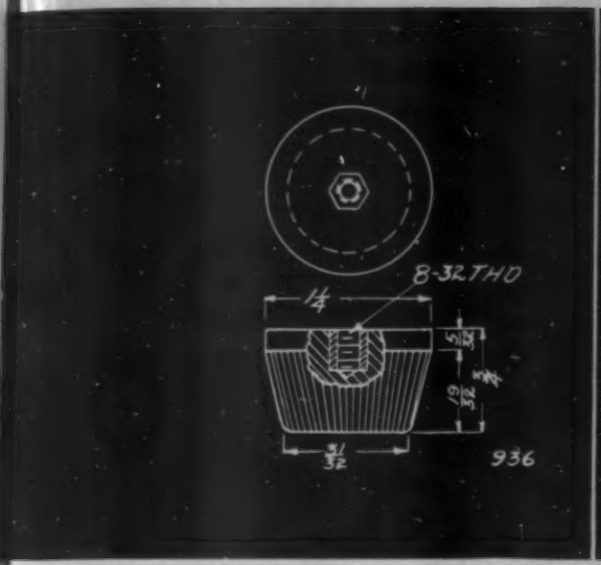
Knob
1210
Cold molded composition
May also be furnished with female thread

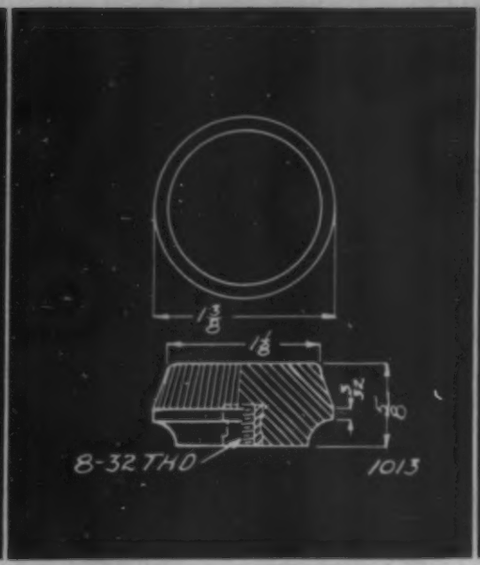


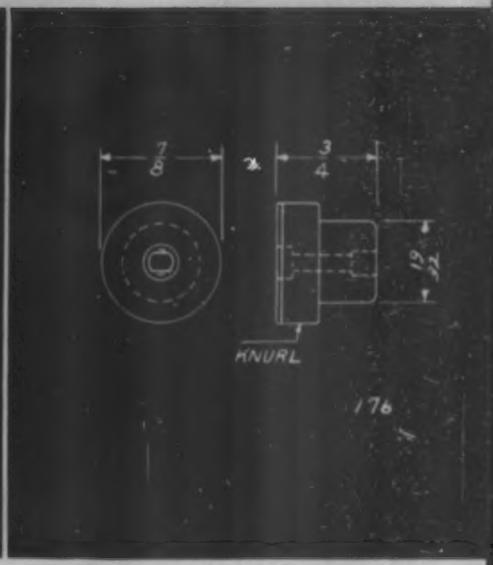
Knob
1849
1993
1963
1898
Cold molded composition



Knob
903
Cold molded composition



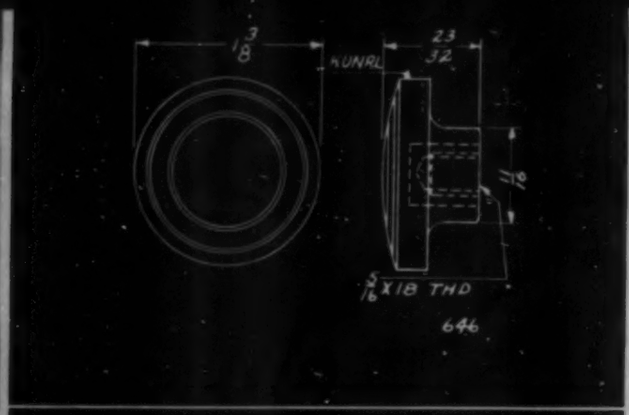




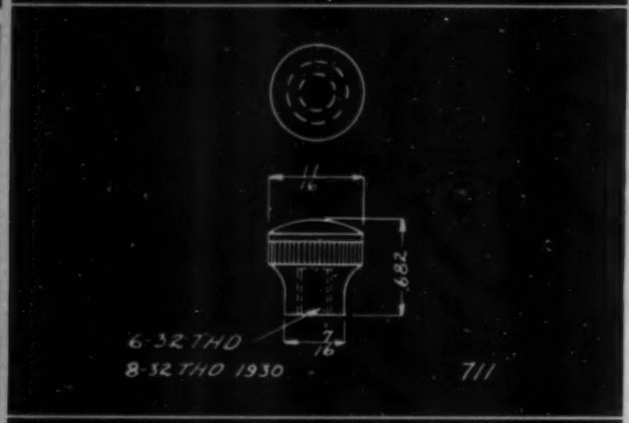
Knob
936
Cold molded composition

Knob
1013
Cold molded composition

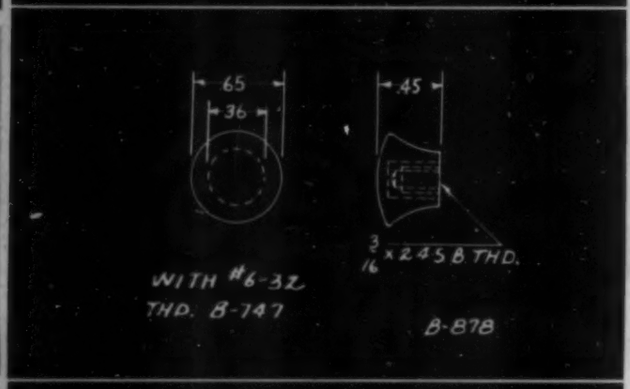
Knob
176
Cold molded composition



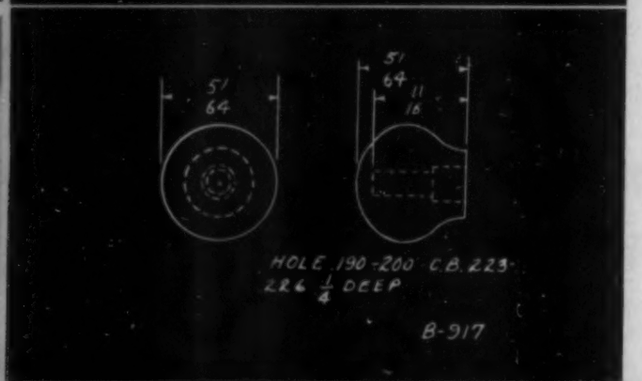
Knob
646
Cold molded composition



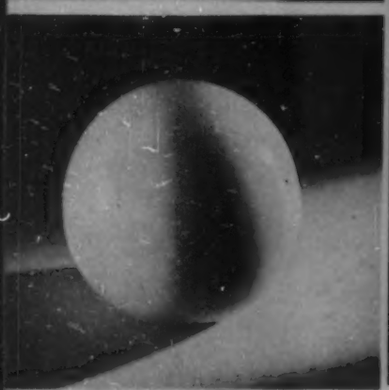
Knob
711 & 1930
Cold molded composition

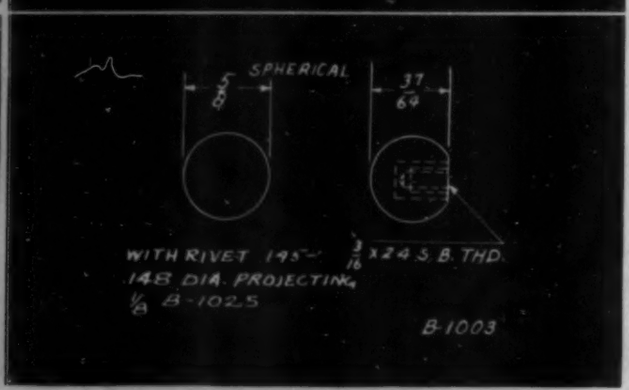


Knob
B878 & 747
Phenolic, urea or cellulose acetate



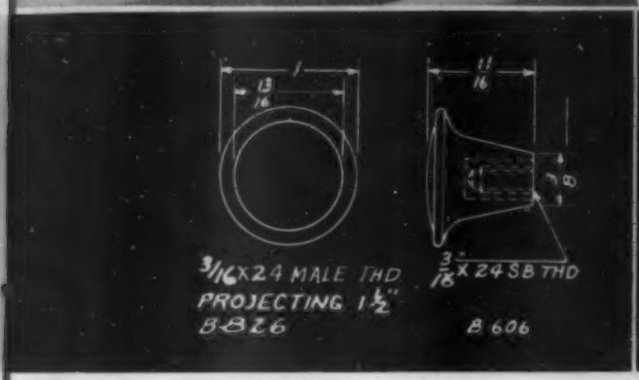
Knob
B917
Phenolic, urea or cellulose acetate



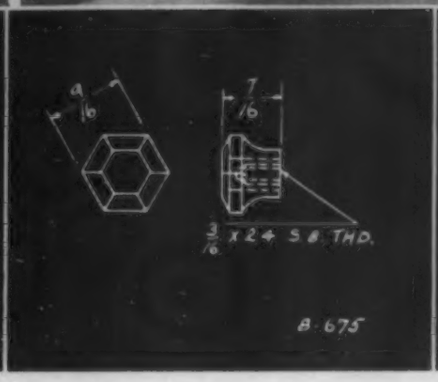


Knob
B1003 & B1025
Phenolic or urea

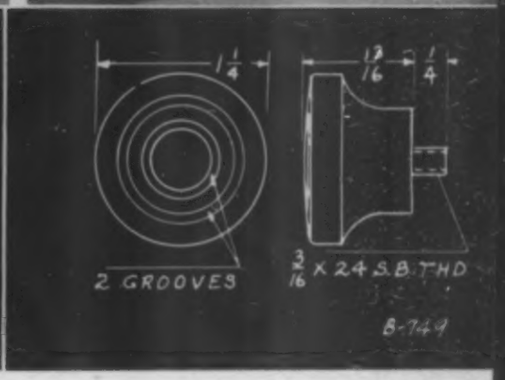
Knob
B606 & B826
Phenolic or urea



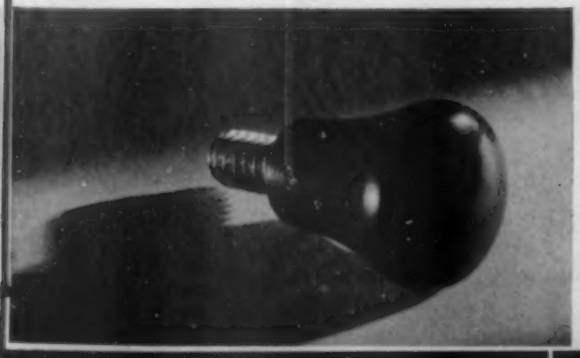
Knob
B675
Phenolic or urea

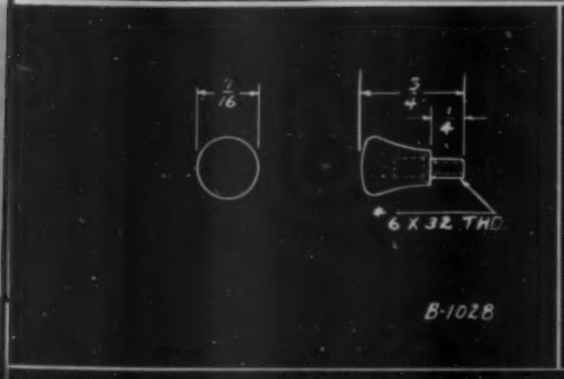


Knob
B749
Phenolic or urea

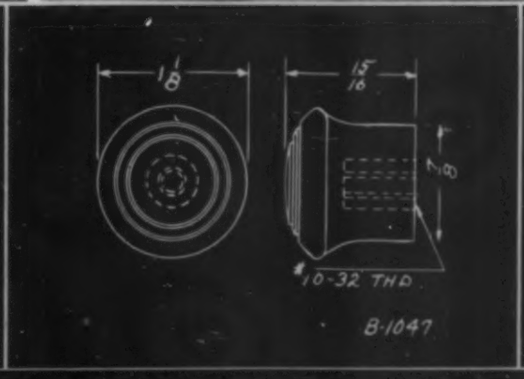


Knob
B1028
Phenolic, urea or cellulose acetate

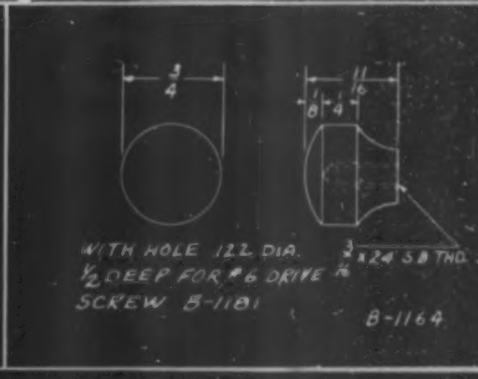




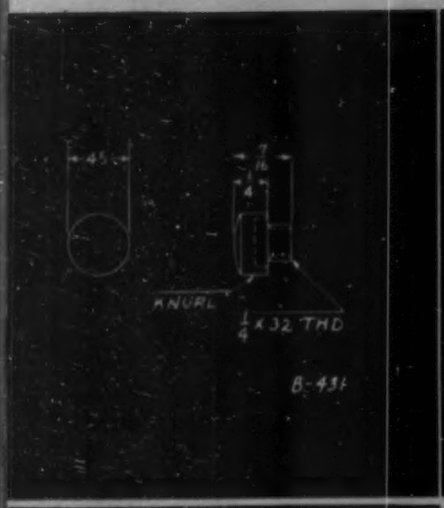
Knob
B1047
Phenolic or urea

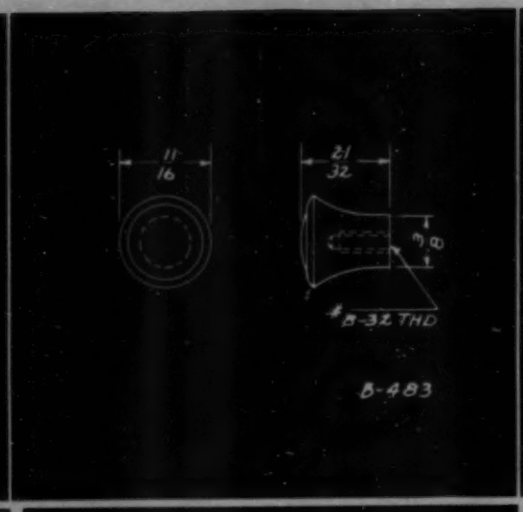


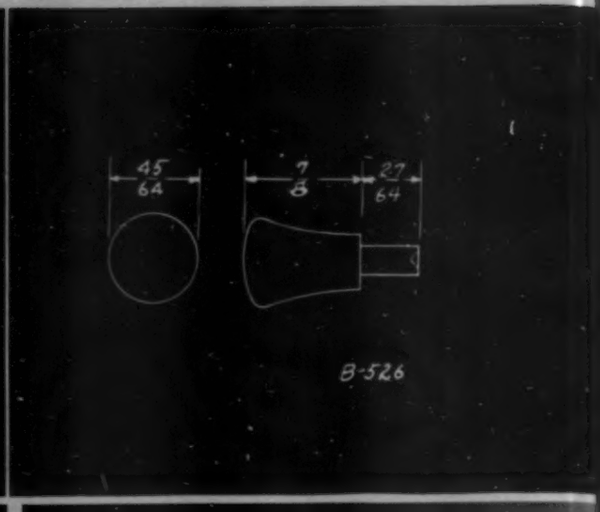
Knob
B1181
B1164
Phenolic or urea

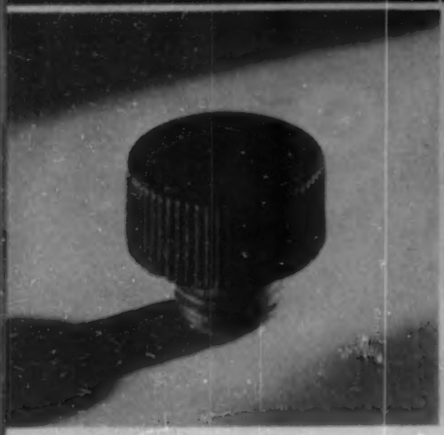


AMERICAN INSULATOR CORPORATION







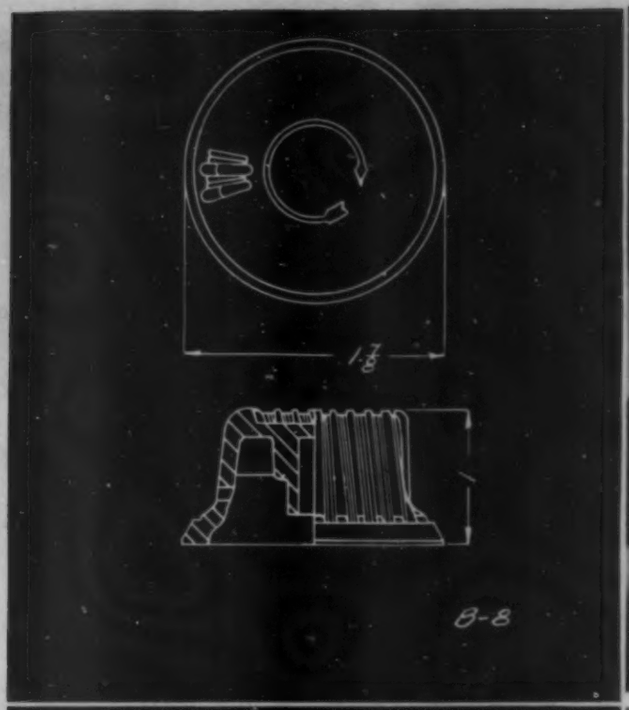


Knob
B431
Phenolic or urea

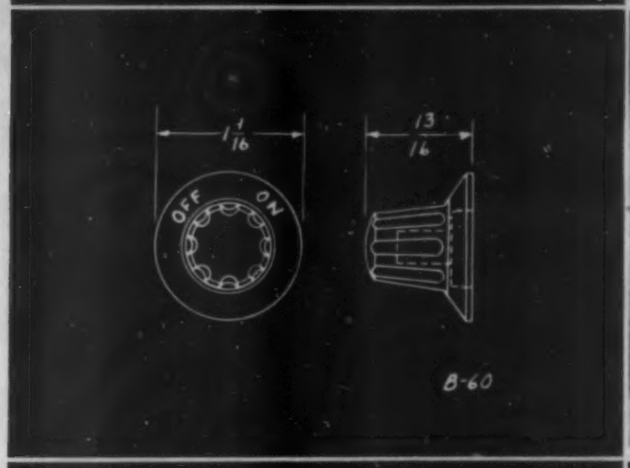
Knob
B483
Phenolic or urea

Can also be supplied with 3/16" stove bolt thread

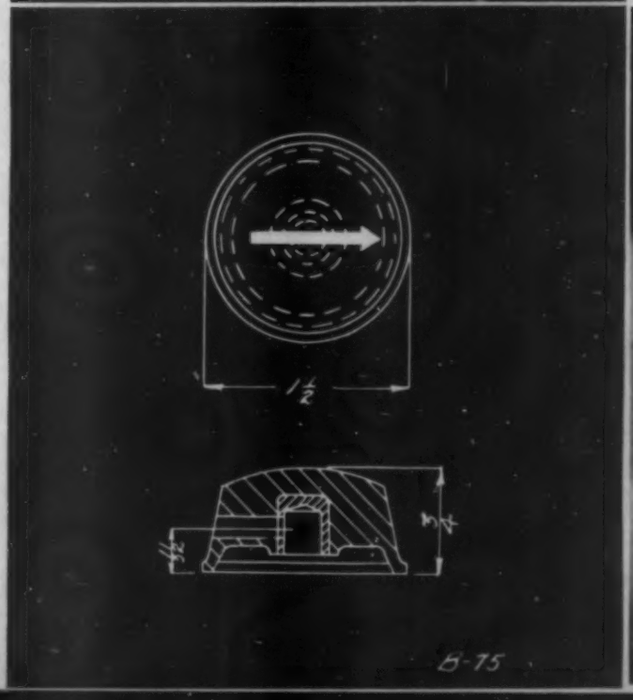
Knob
B526
Phenolic, urea or cellulose acetate



Radio knob
B8
Phenolic



Radio knob
B60
Phenolic

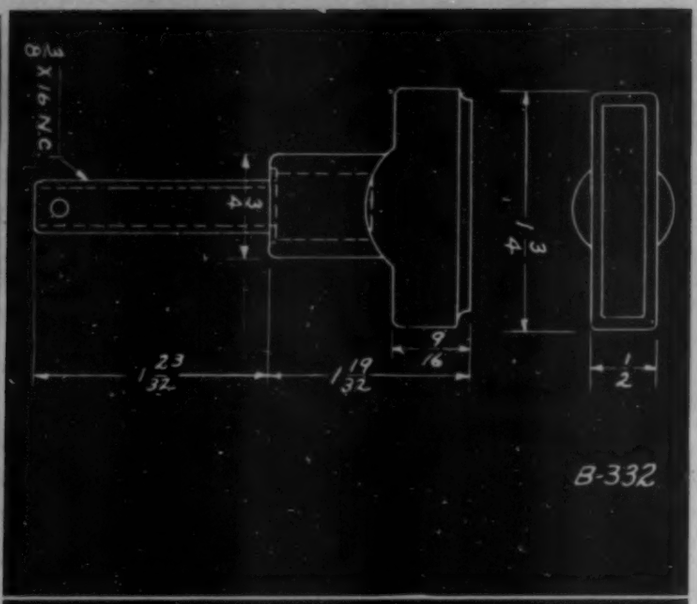


Radio knob
B75
Phenolic

Heater screw register handle

B332

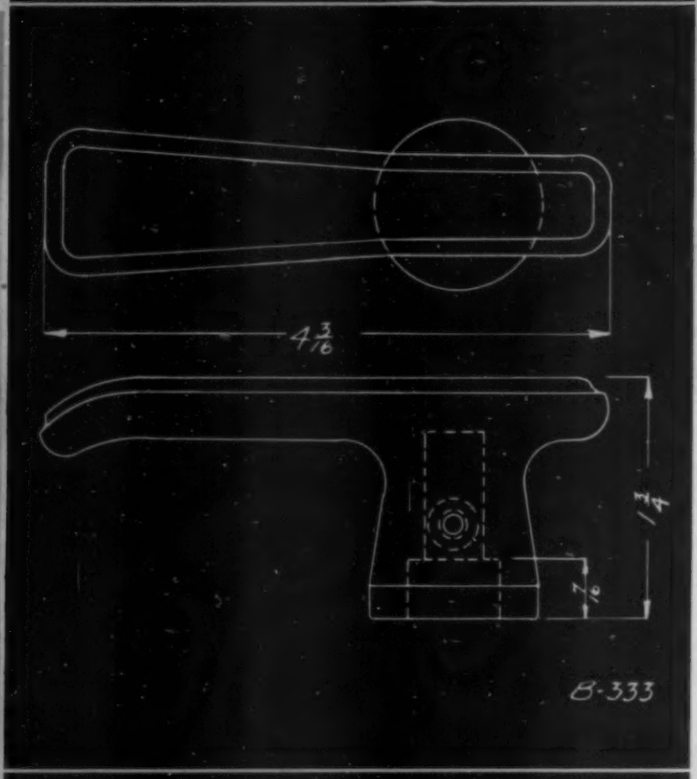
Phenolic



Heater ash pit door handle

B333

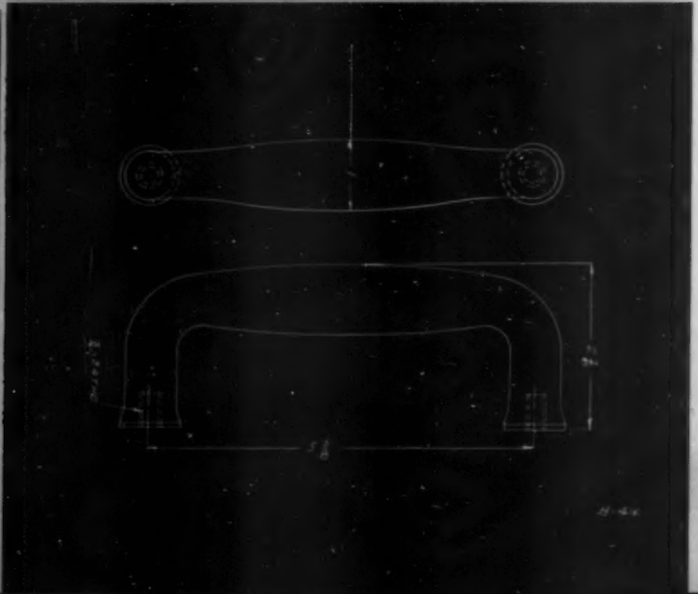
Phenolic

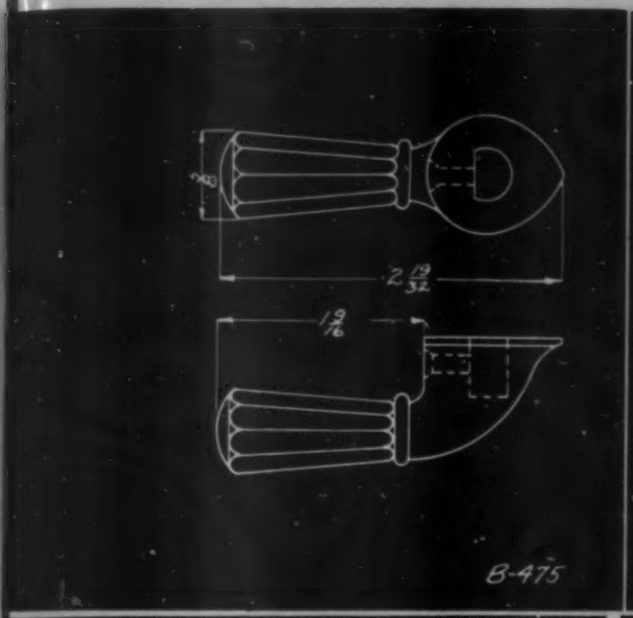


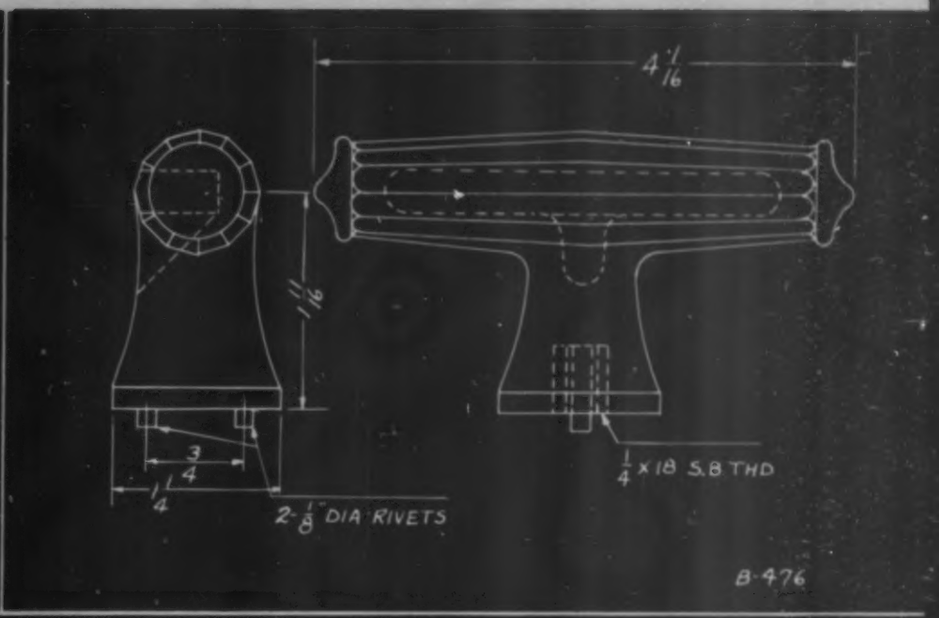
Oven door handle for cooking range

B416

Molded phenolic







Gas cock handle

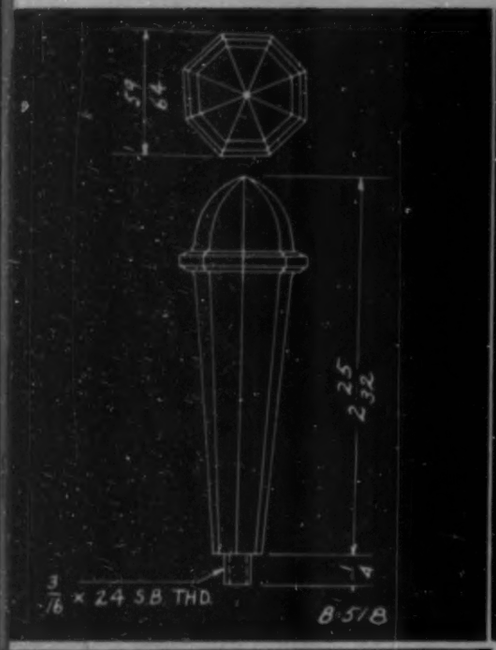
B475

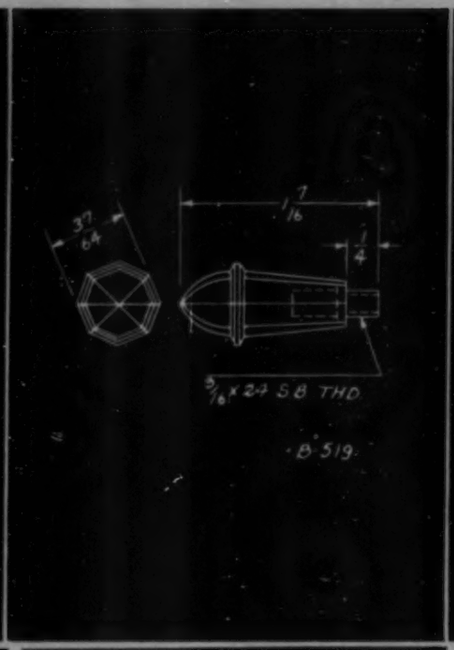
Molded from phenolic or urea materials

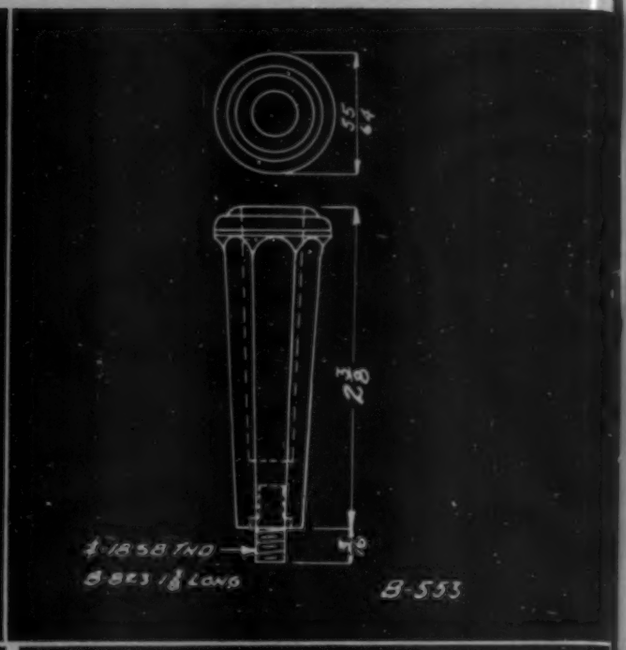
Oven door handle

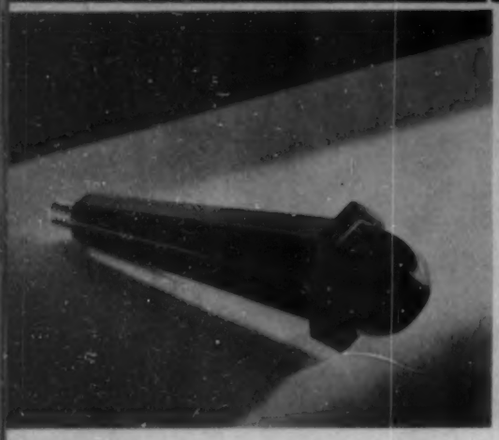
B476

Molded from phenolic or urea materials



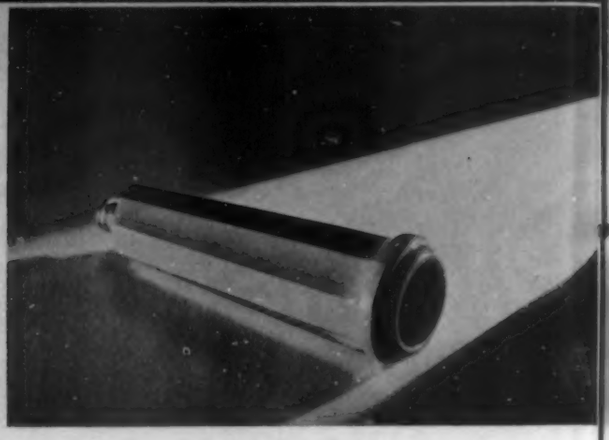




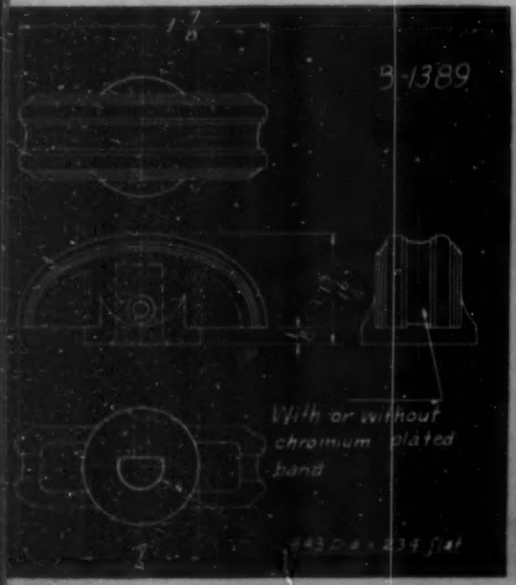


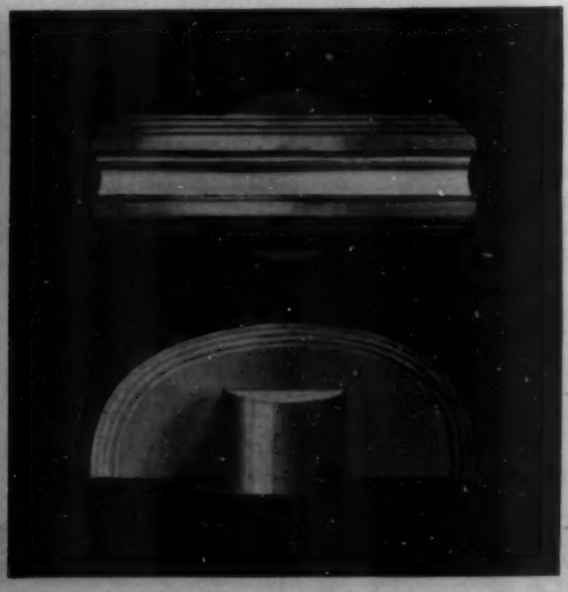
Pendant handle
B518
Molded from phenolic material

Short pendant handle
B519
Phenolic



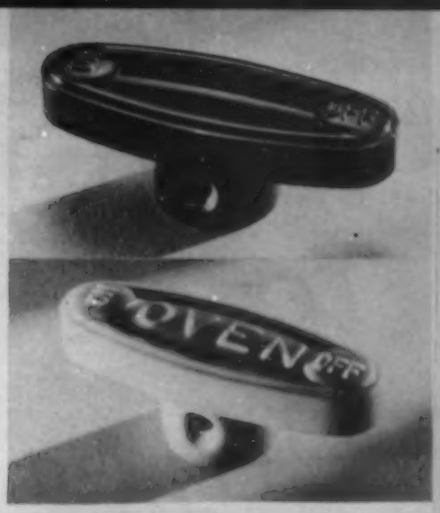
Pendant handle
B553
Phenolic and urea materials



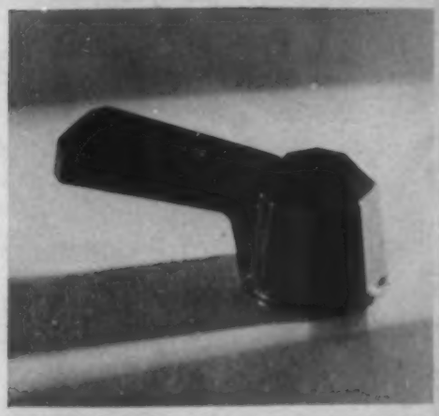


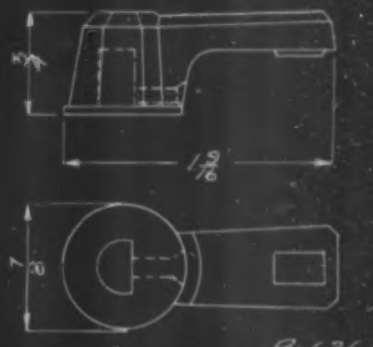
Gas cock handle
B1389
Phenolic or urea

Gas cock handle
B655
Molded phenolic or urea

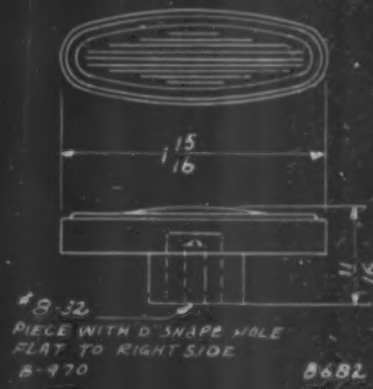


Gas cock handle
B626
Molded phenolic or urea

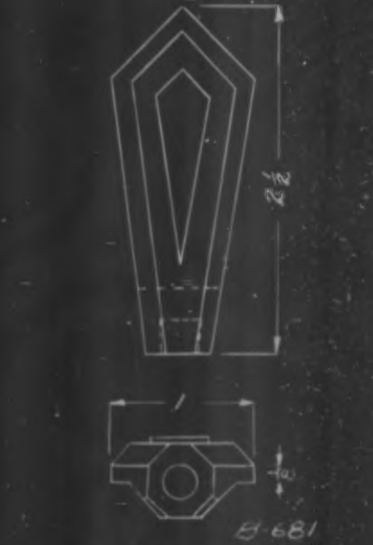


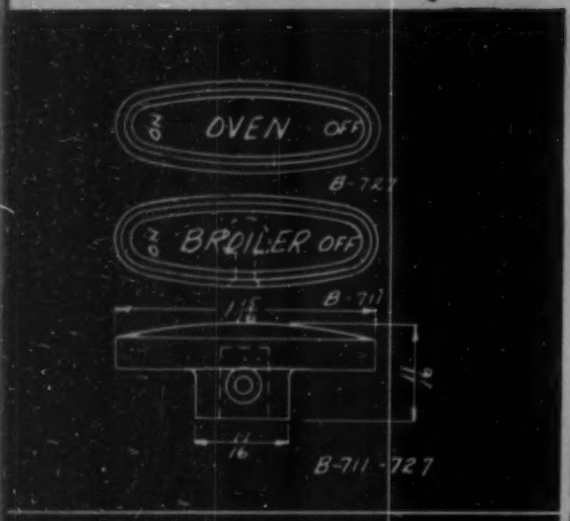


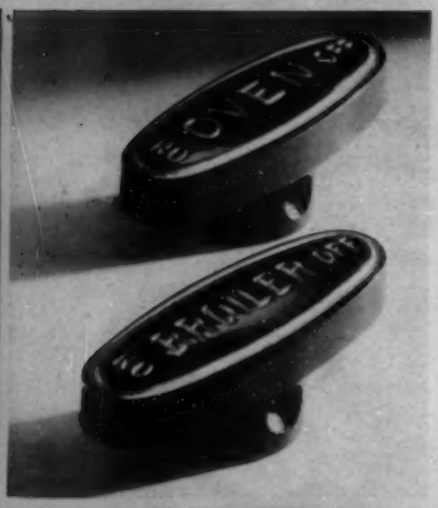
Gas cock handle
B682
Molded phenolic or urea



Pendant handle
B681
Molded phenolic or urea



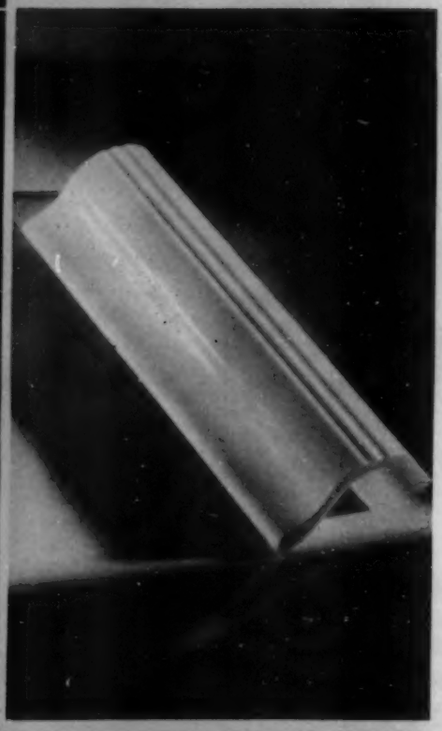




Gas cock handle

B727 & B711

Urea or phenolic in colors



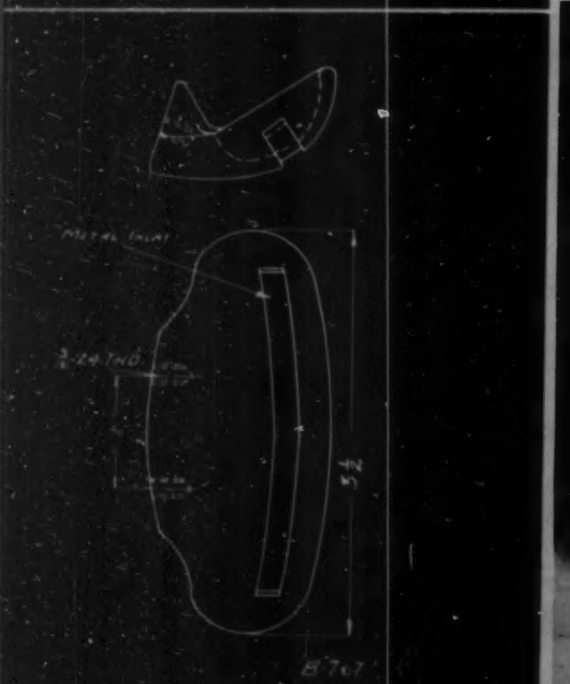
Oven door handle

or

Drawer pull

B765

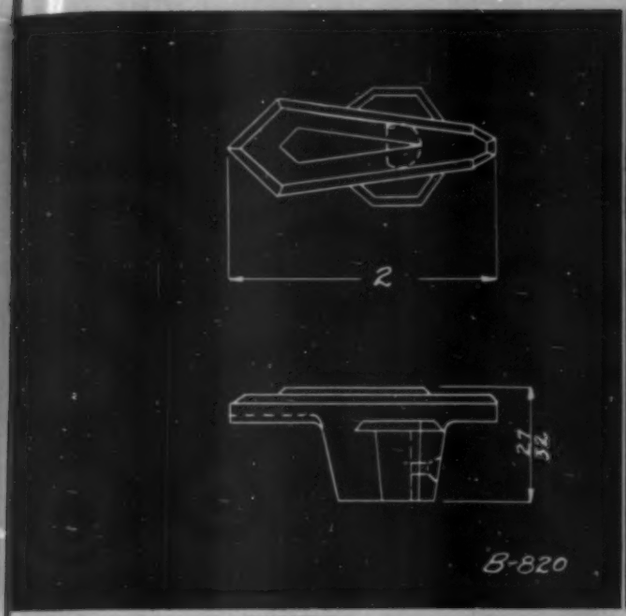
In phenolic or urea materials in colors

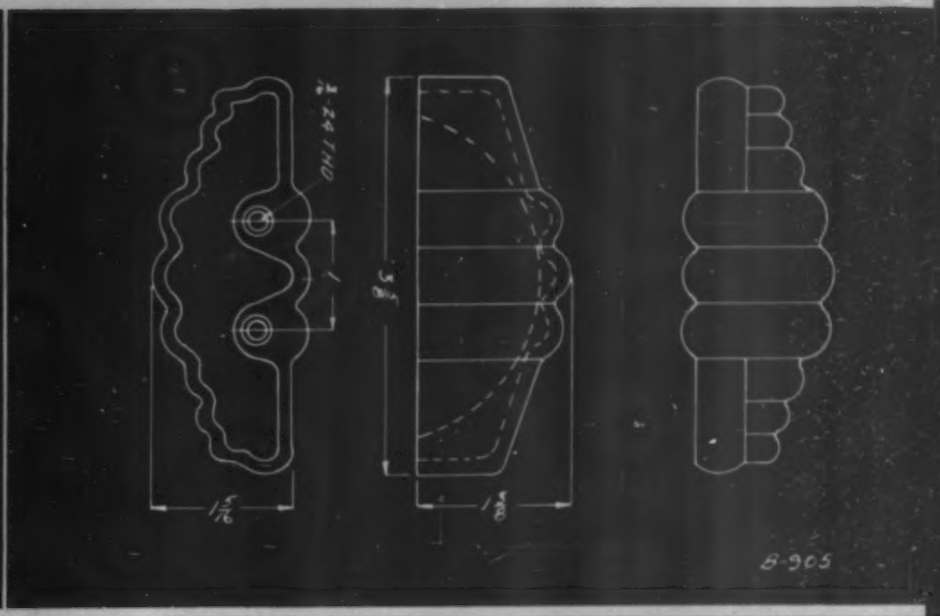


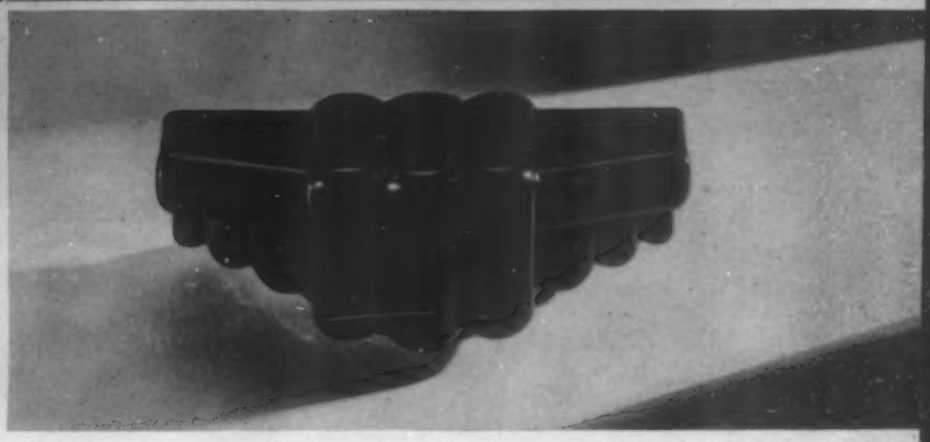
Handle for trays, heaters, grills, etc.

B767

Phenolic







Gas cock handle

B820

Molded from phenolic or urea materials in colors

B680

Same as above but having flat of hole on top

Drawer pull or door handle

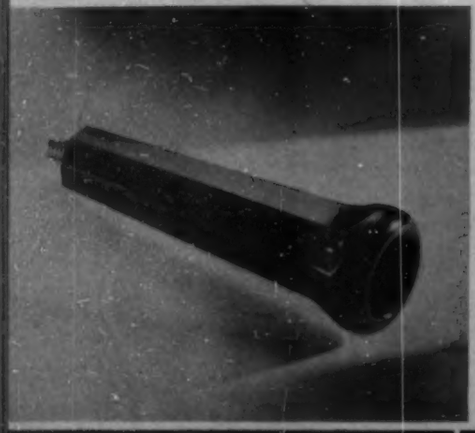
B905

Molded from phenolic materials

Large pendant handle

B990

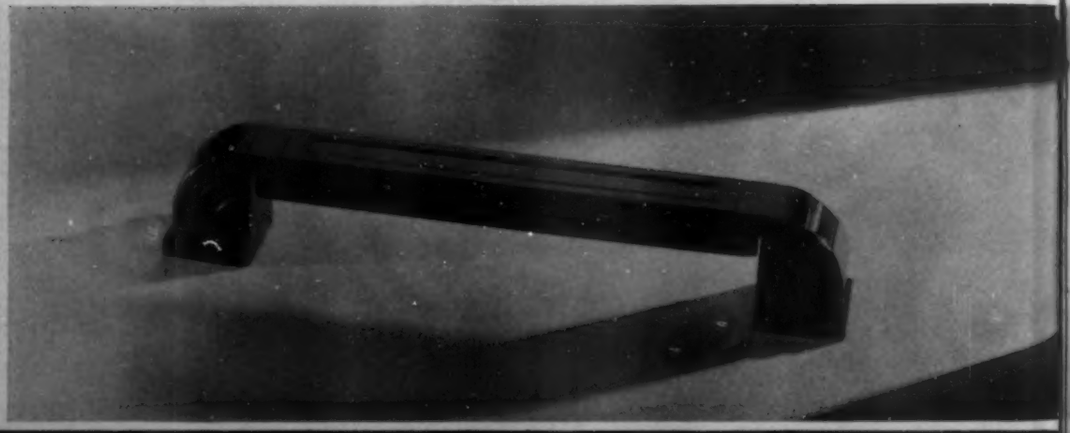
Phenolic materials

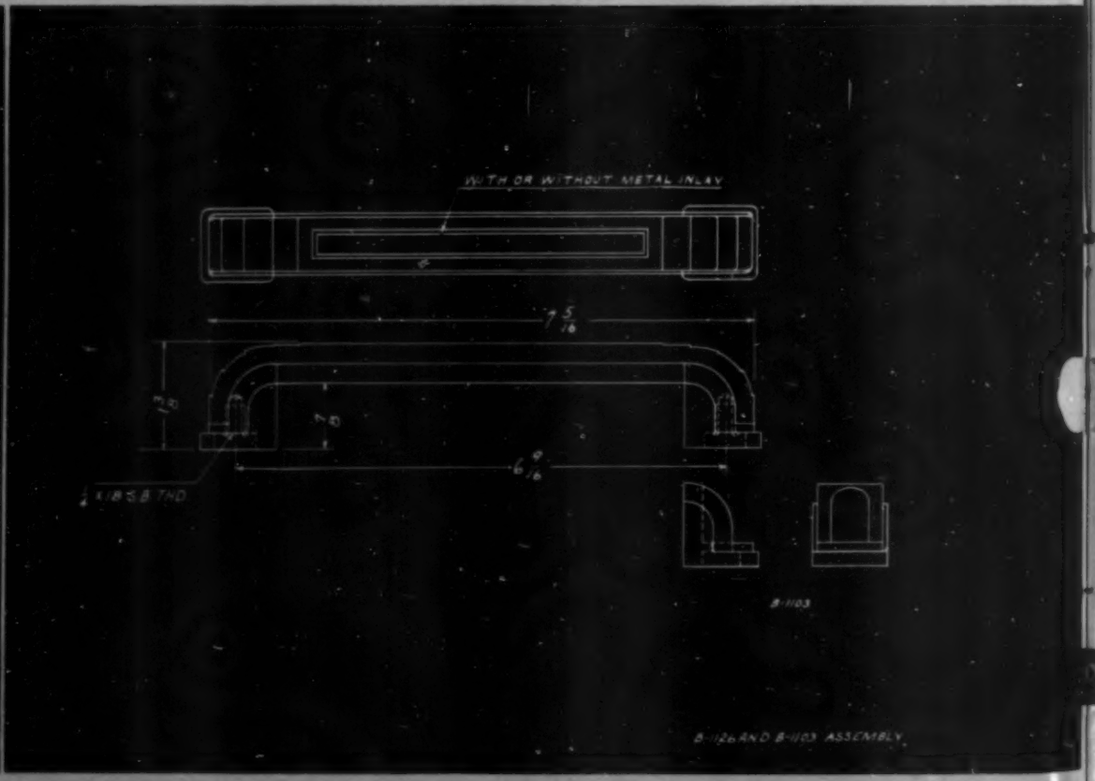


Oven door handle assembly

B1126

Molded from phenolic or urea in variety of colors and contrasts

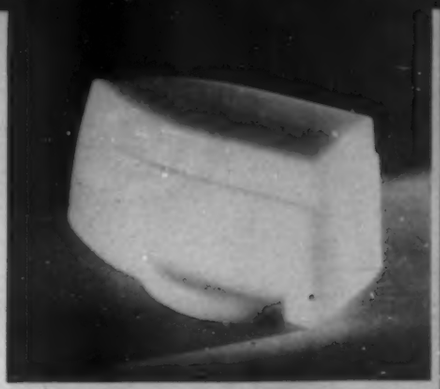


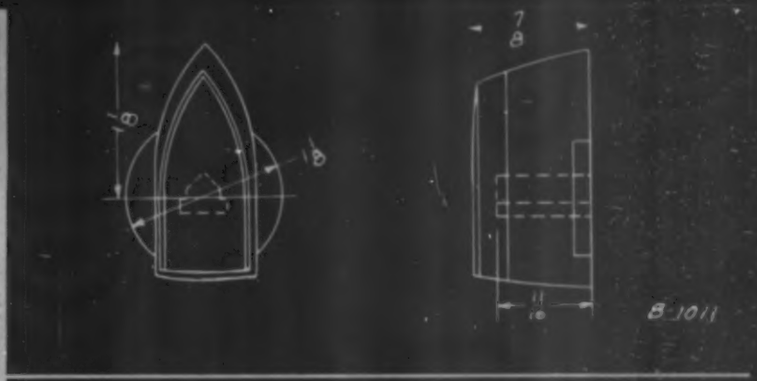


Heater switch indicator handle

B1011

Molded from phenolic or urea materials

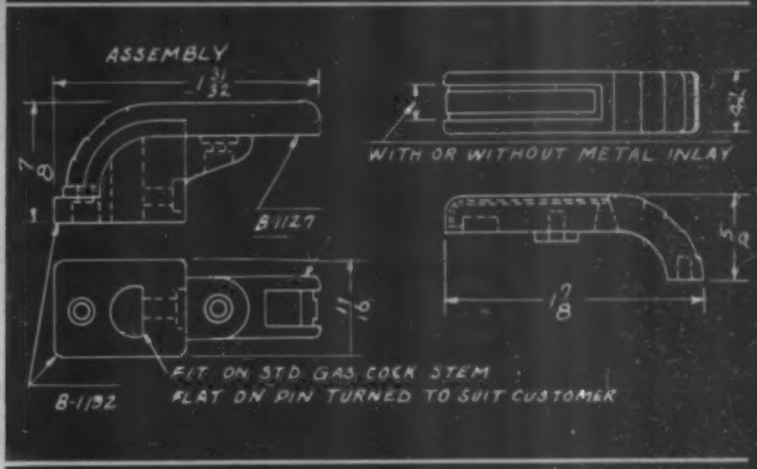




Stove, gas cock handle

B1192

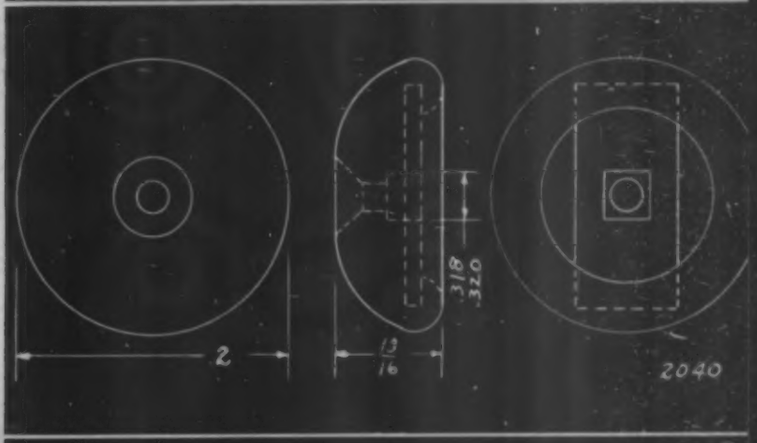
Molded from phenolic or urea materials in contrasting colors



Valve handle

2040

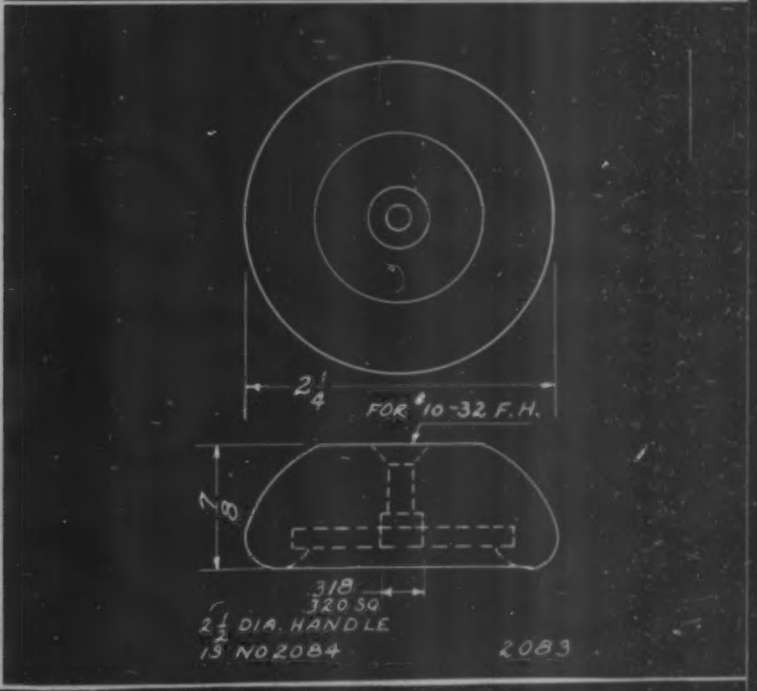
Cold molded composition



Valve handle

2083 and 2084

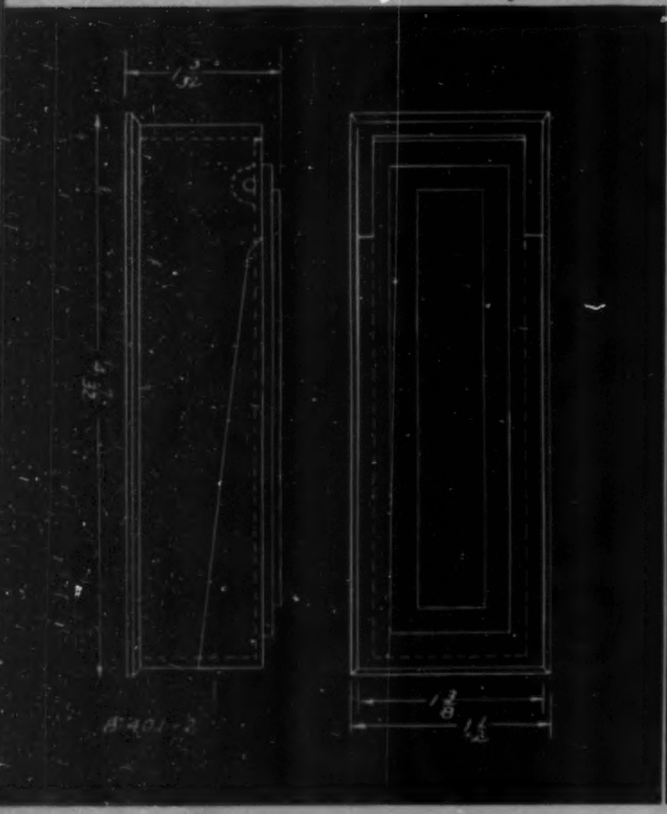
Cold molded composition



Sales promotion container for packaging safety razor or similar small article

B401-2

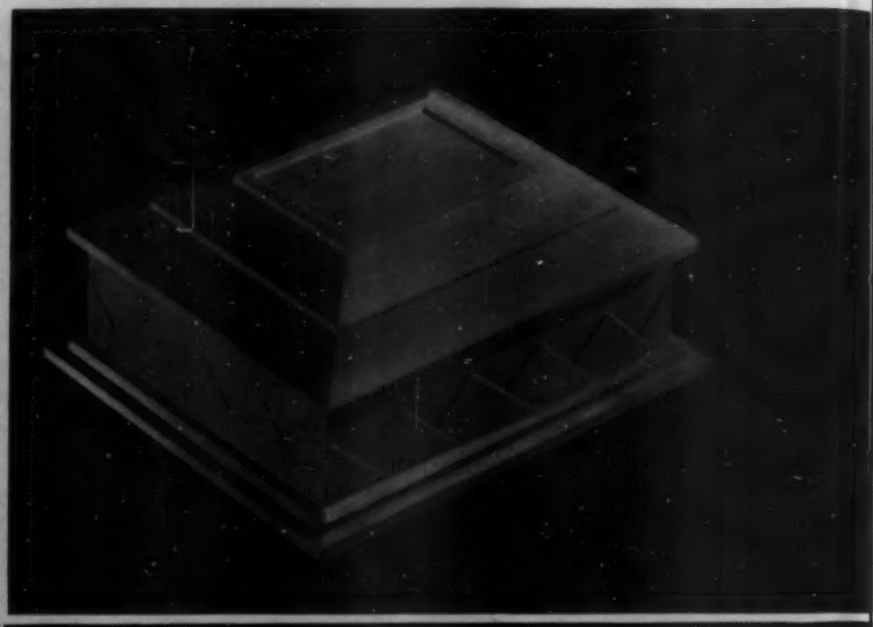
Molded from urea or phenolic materials

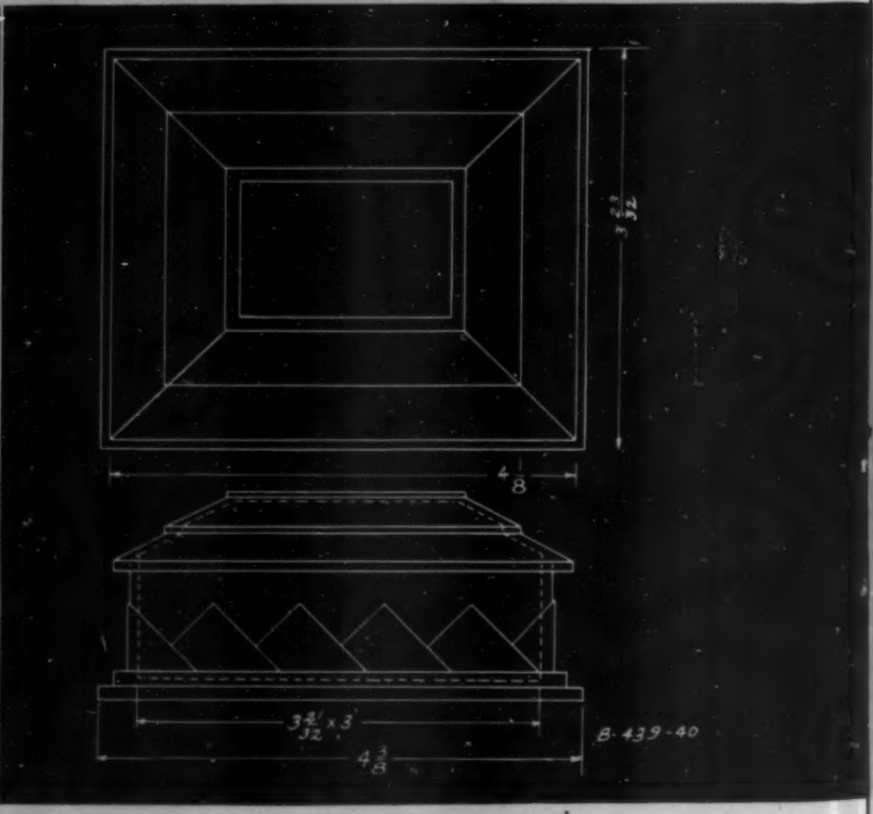


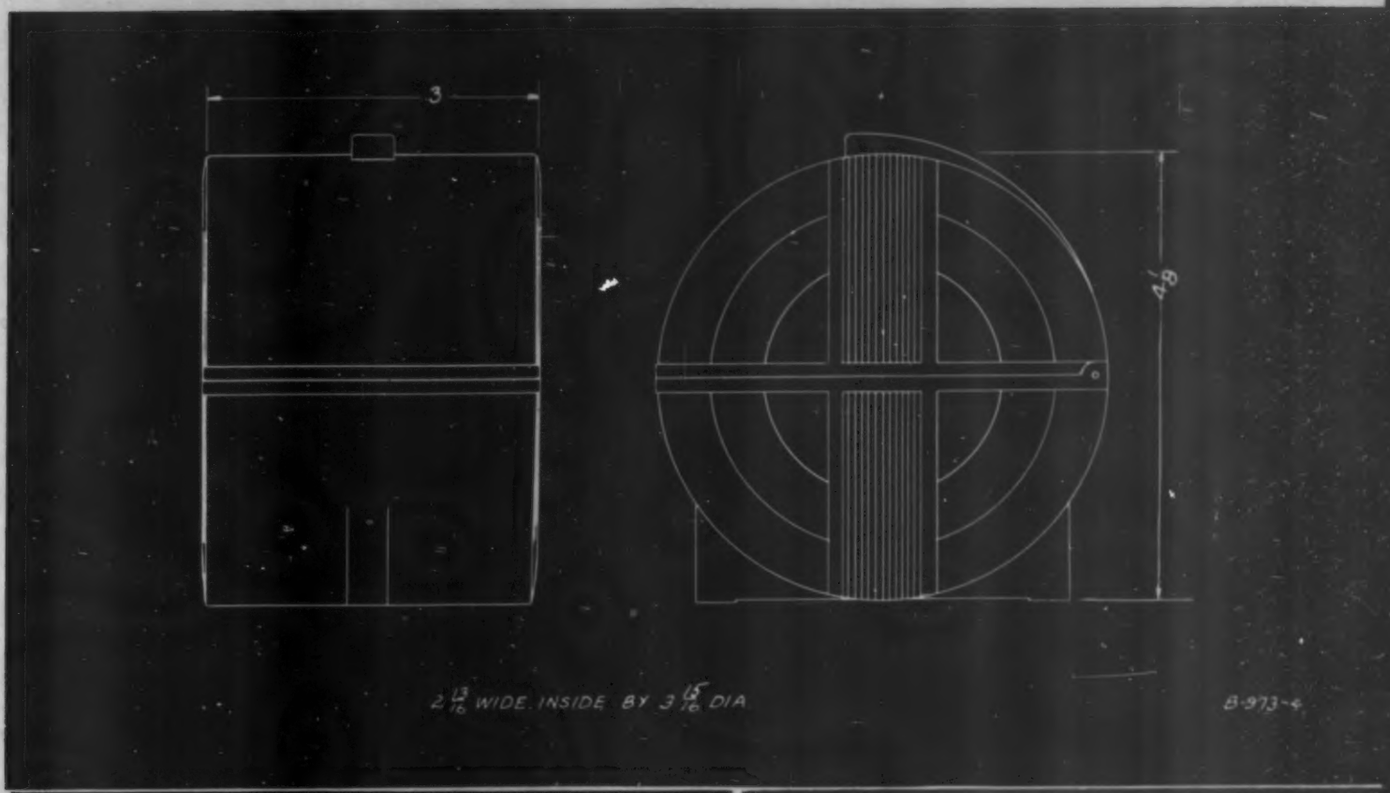
Cigarette box

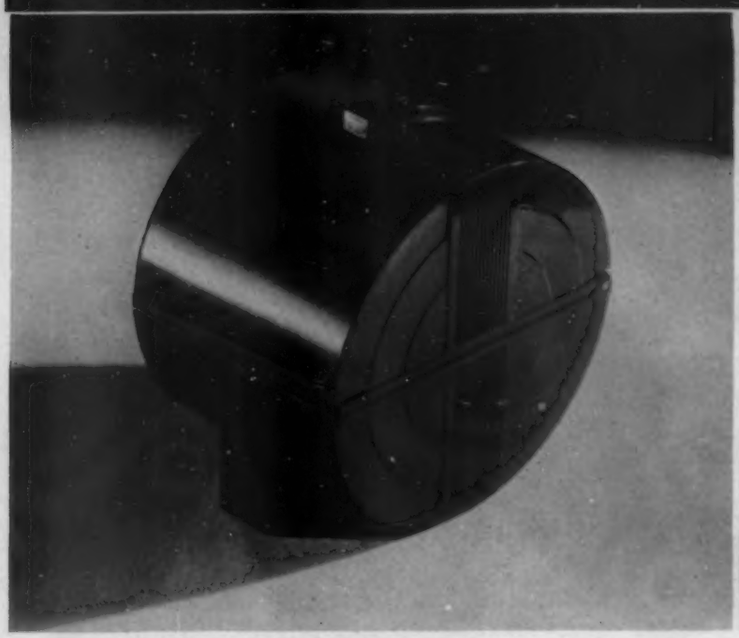
B439-40

Molded from urea or phenolic materials in unlimited variety of colors









Sales promotion packaging container which serves as cigarette or jewel box after delivery of merchandise

B973-4

Made in phenolic and urea combination of colors

Sales promotion container originally designed for packaging belts—can be used for variety of articles of merchandise and is an attractive cigarette case after original contents are delivered

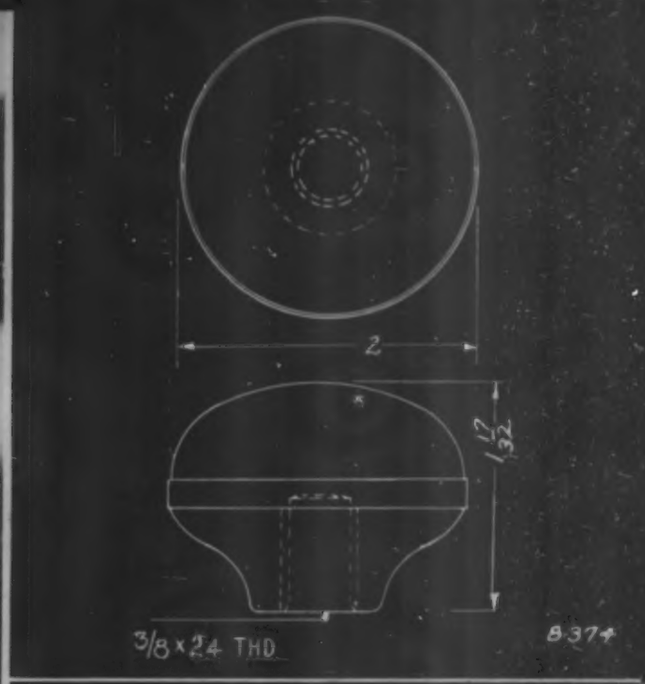
B827-B978

Made in phenolic or urea materials

Gear shift lever ball

B374

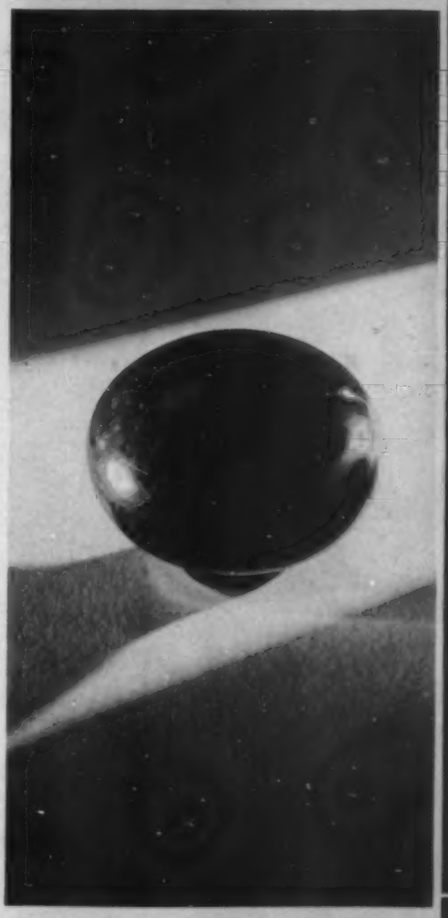
Cellulose acetate, ureas or phenolics—in variety of colors or variegations

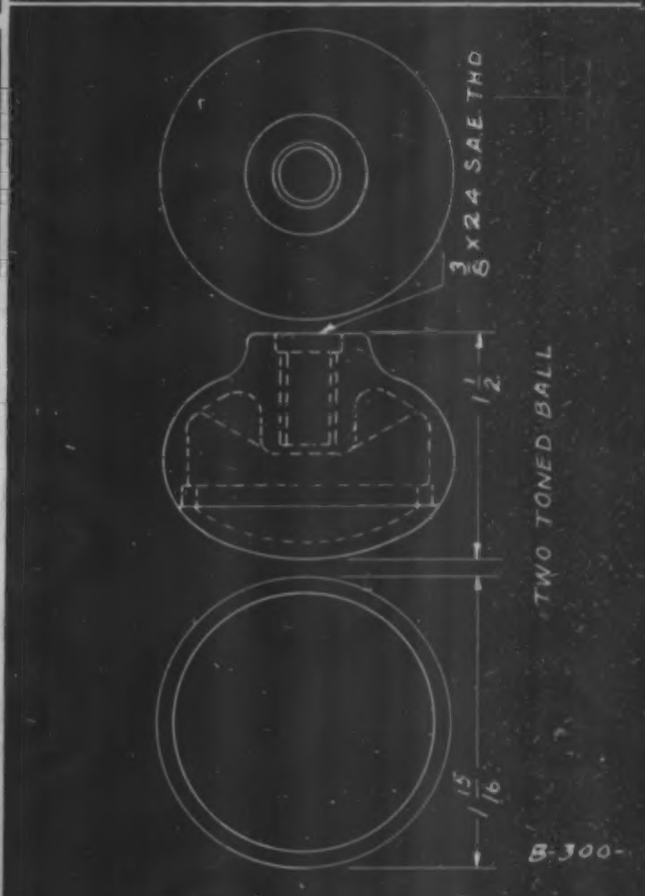


Gear shift lever ball

B300-1

Combination of molded materials to produce color contrasts and variegations

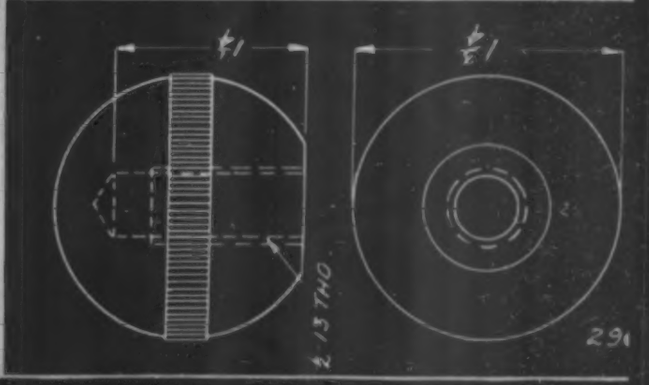




Gear shift lever ball

296

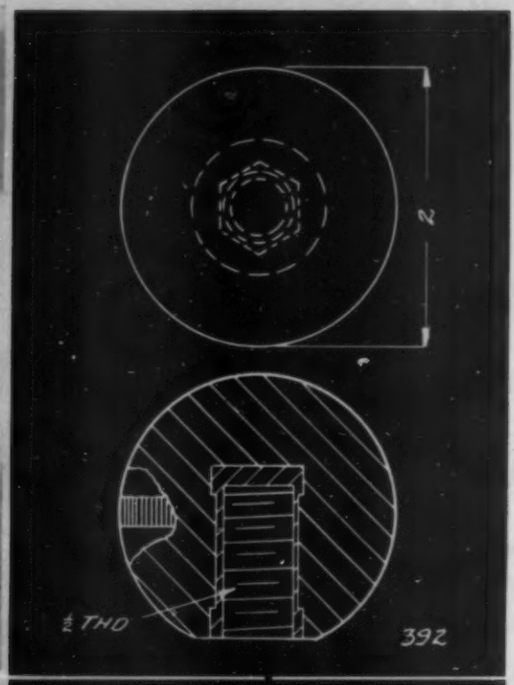
Cold molded composition



Gear shift lever ball

392

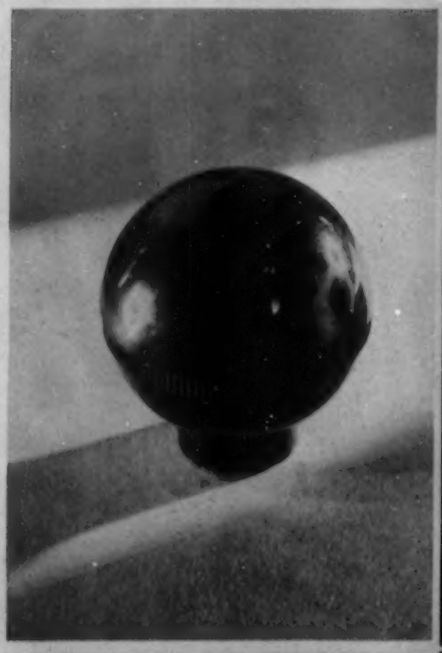
Cold molded composition

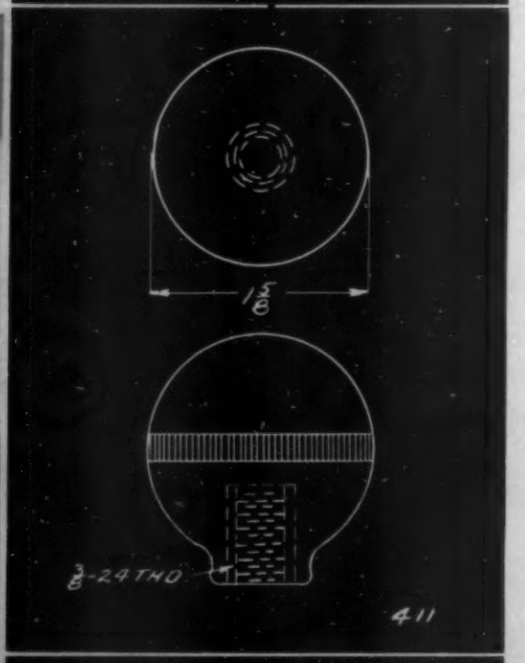


Gear shift lever ball

411

Cold molded composition

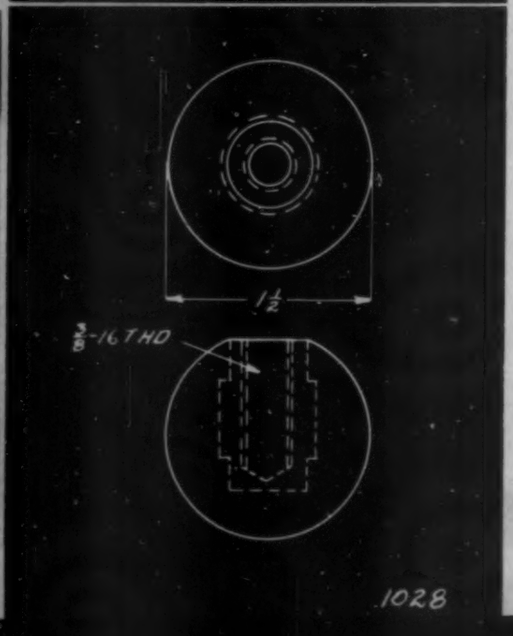




Spherical handle for operating lever for ventilators, transmissions or similar devices

1028

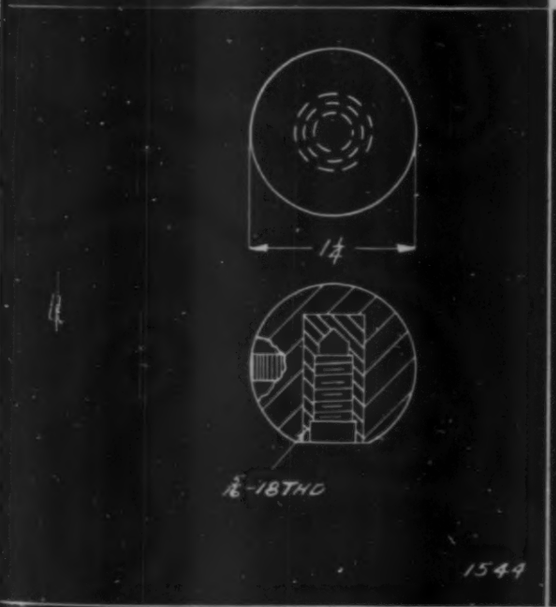
Cold molded composition



Spherical ball handle for operating lever applicable to variety of purposes

1544

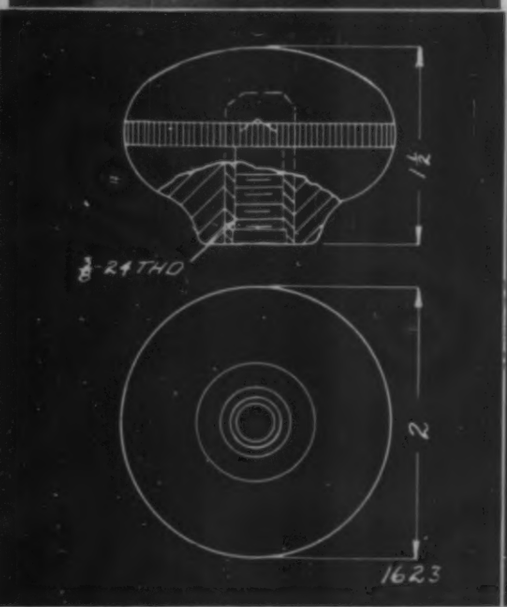
Cold molded composition



Gear shift lever ball

1623

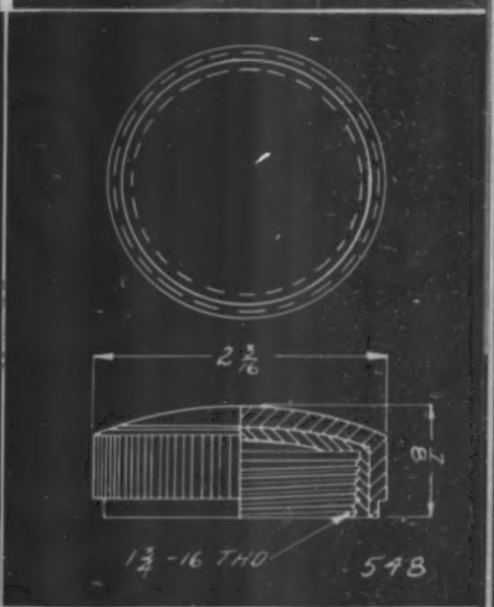
Cold molded composition



Radiator cap

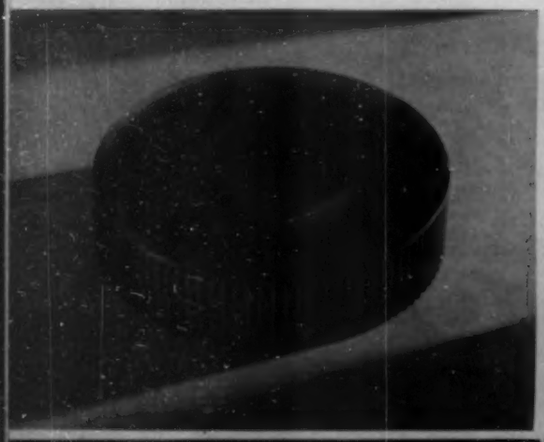
548

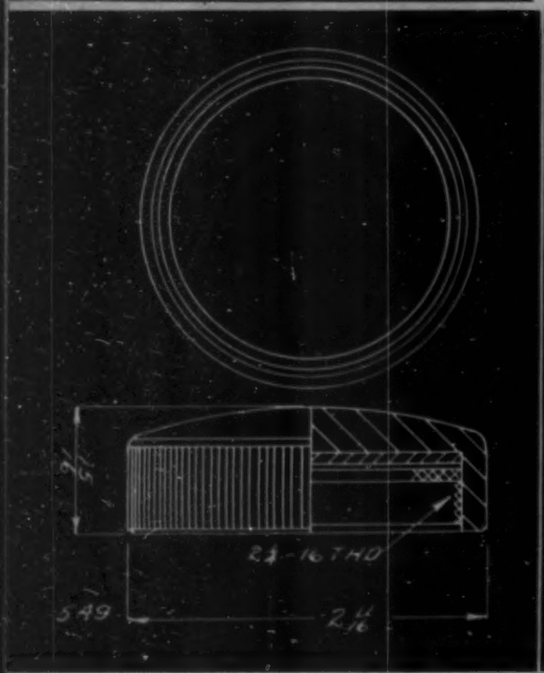
Cold molded composition



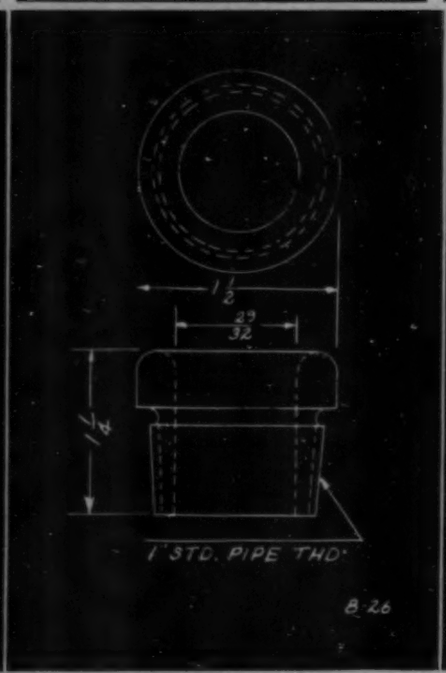
AMERICAN INSULATOR CORPORATION

Radiator cap
549
Cold molded composition

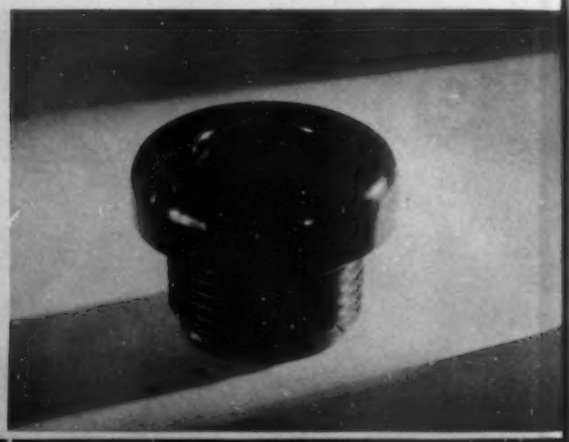


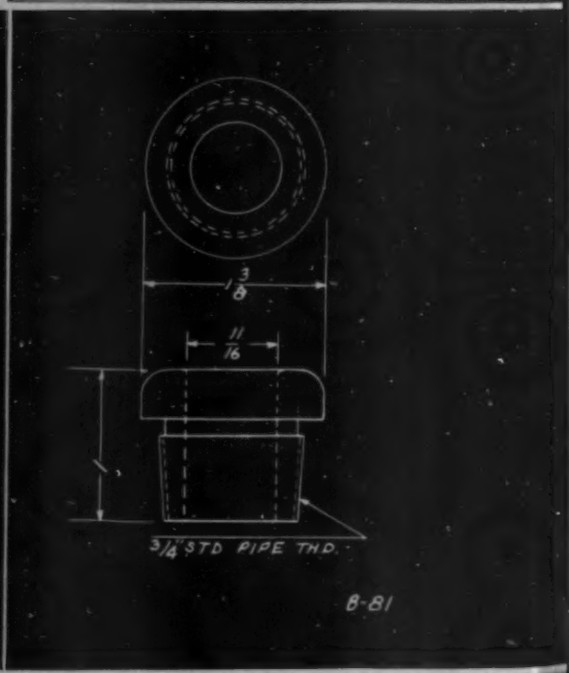


Conduit bushing
B26
Molded phenolic material

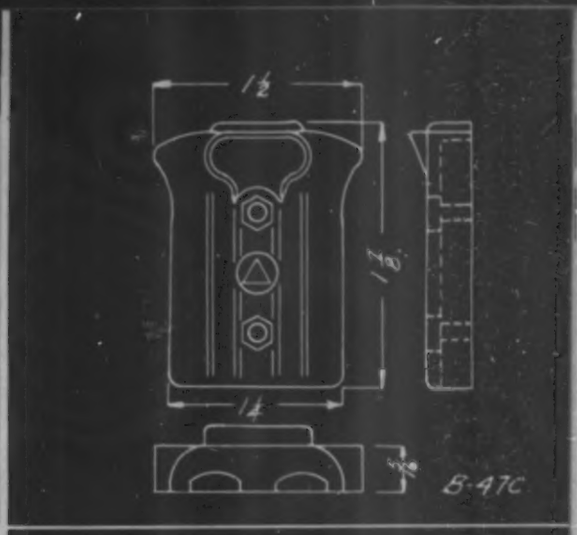


Conduit bushing
B81
Molded phenolic material

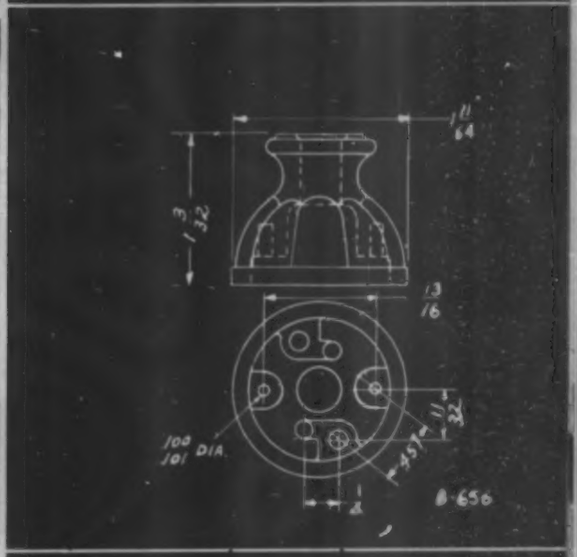




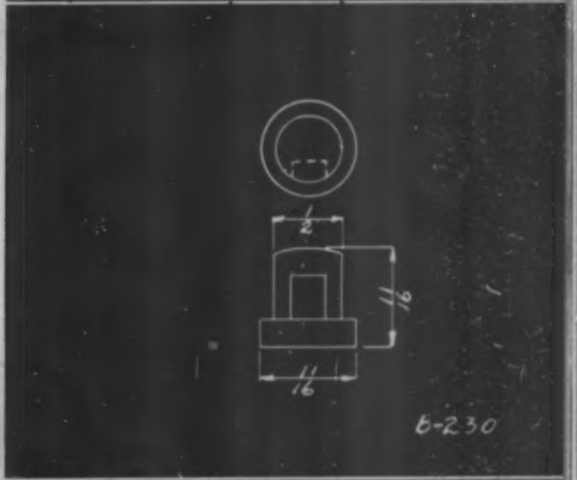
Connector plug
B470
Molded phenolic material



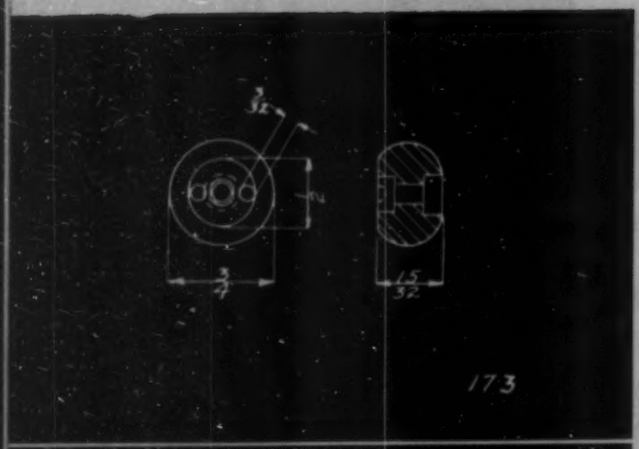
Pull cap
B656
Molded phenolic material



Push button
B230
Molded phenolic material



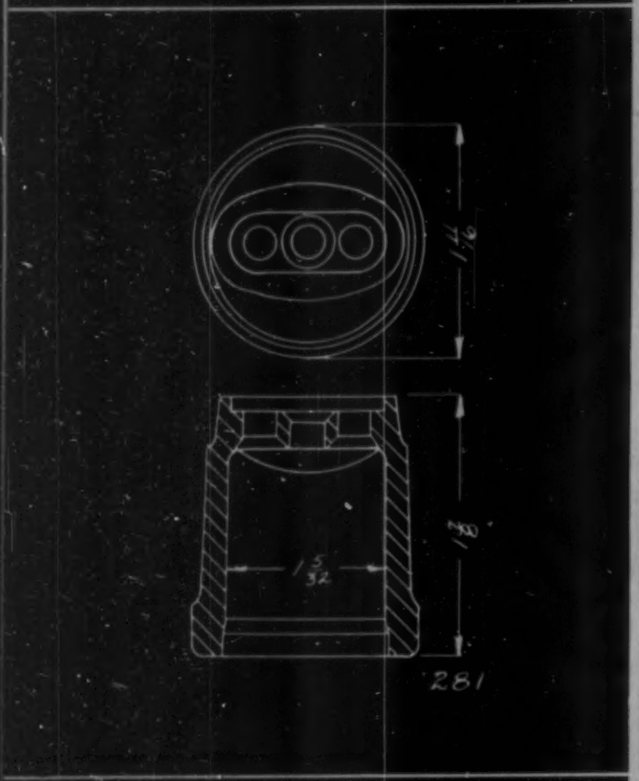
Push button
B576
Molded phenolic material



Foot for percolator or other appliance where heat or electrical insulator is required

173

Cold molded composition



Weatherproof electrical socket husk

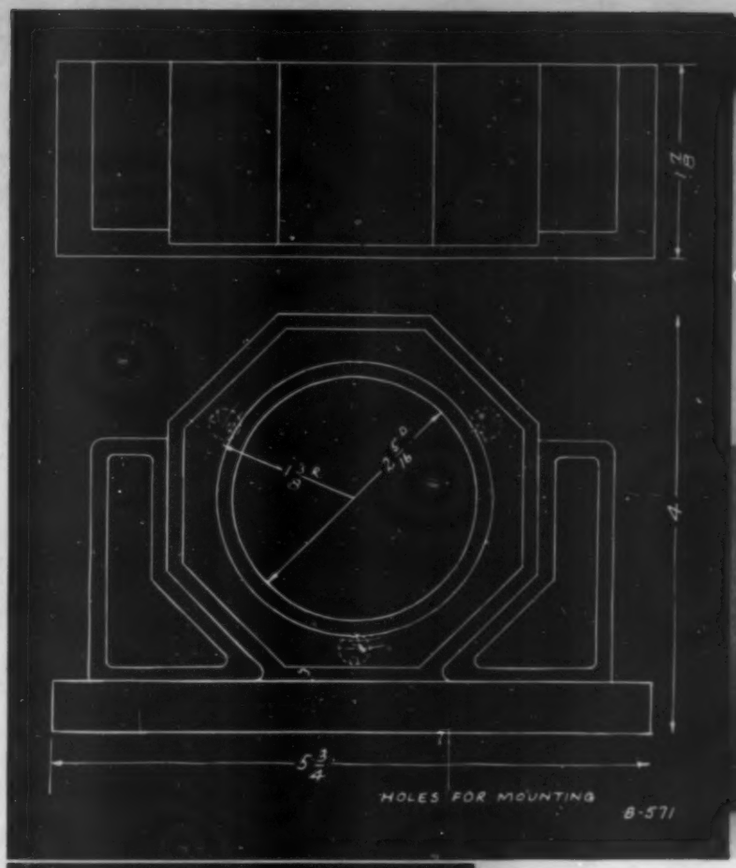
281

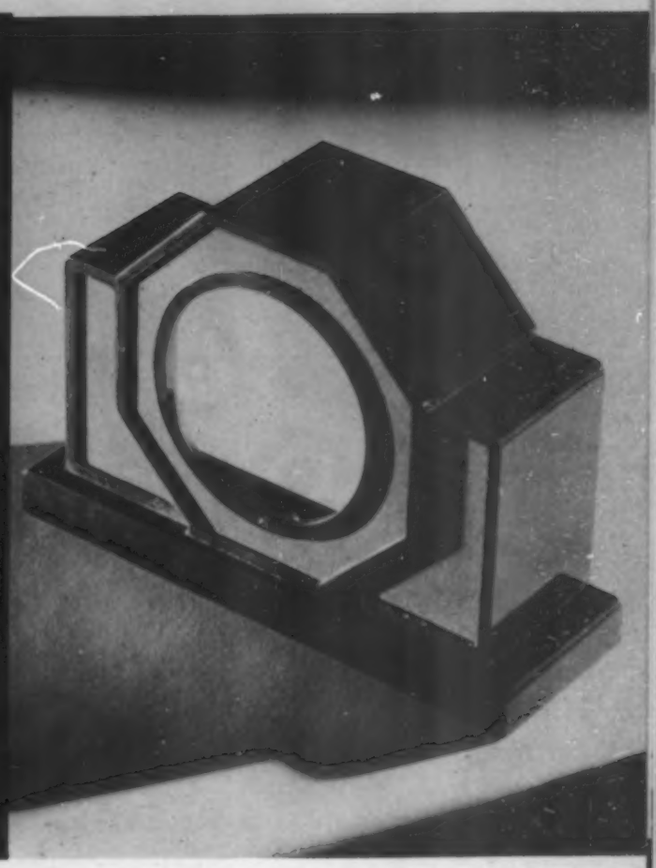
Cold molded composition

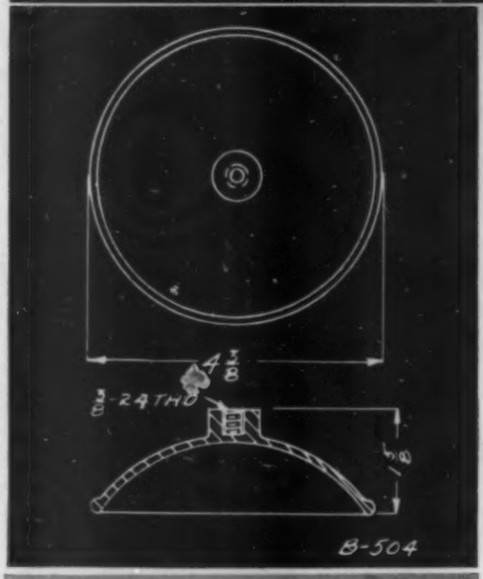
Connector plug

633

Cold molded composition







Base for lamp or other upstanding object

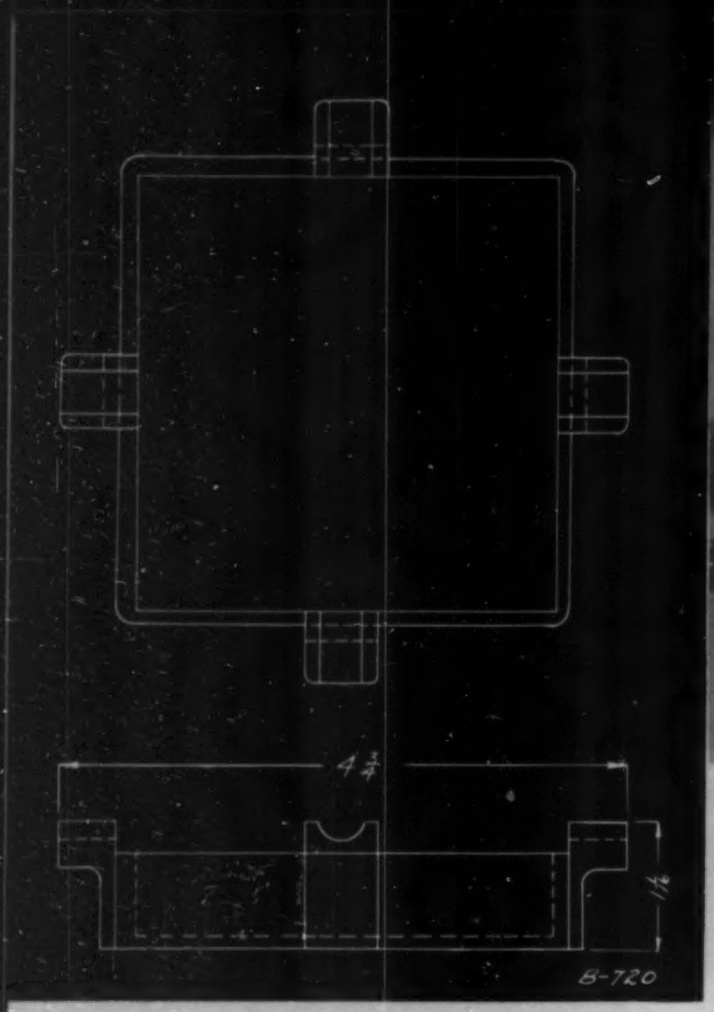
B504

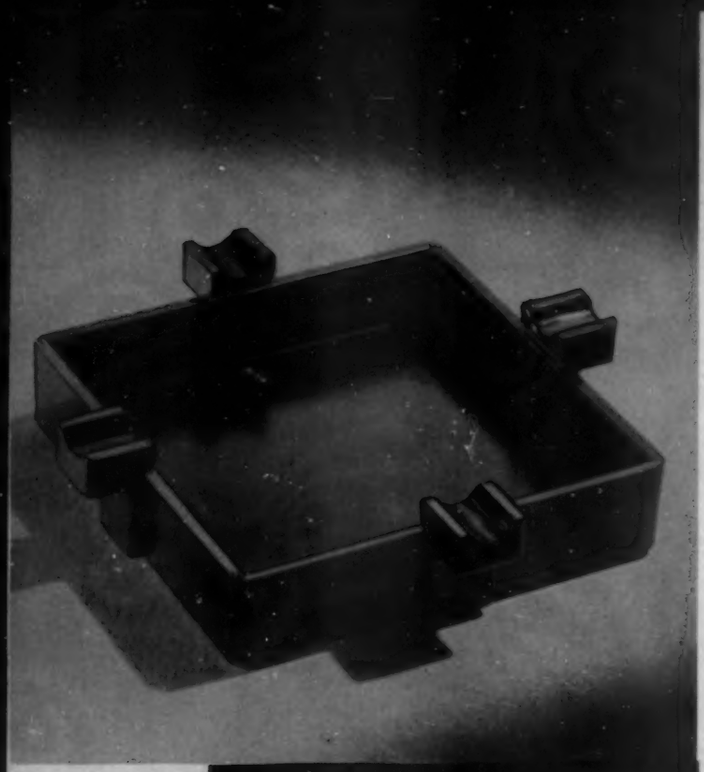
Phenolic

Clock or other instrument case

B571

Phenolic, urea or cellulose acetate

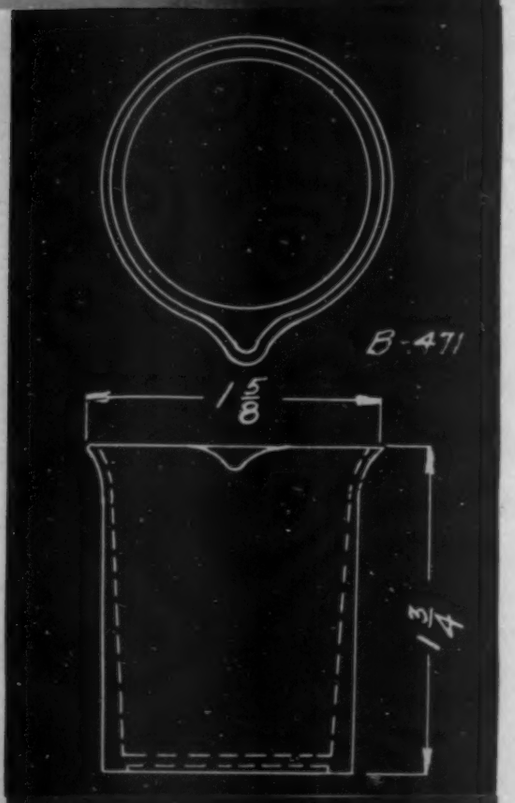




Ash tray

B720

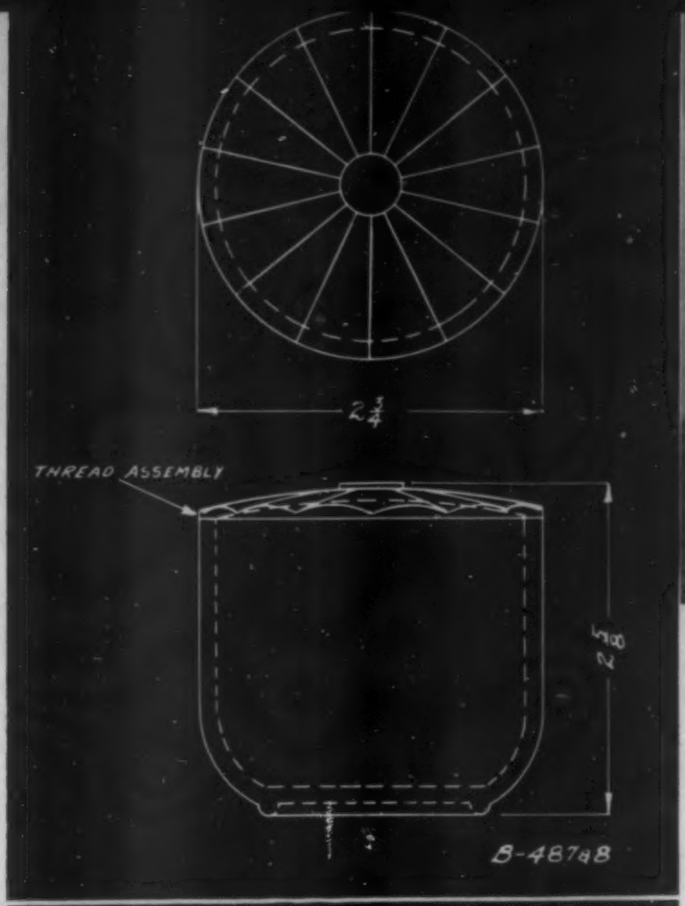
Made from phenolic material especially resistant to concentrated heat



Individual creamer or beaker

B471

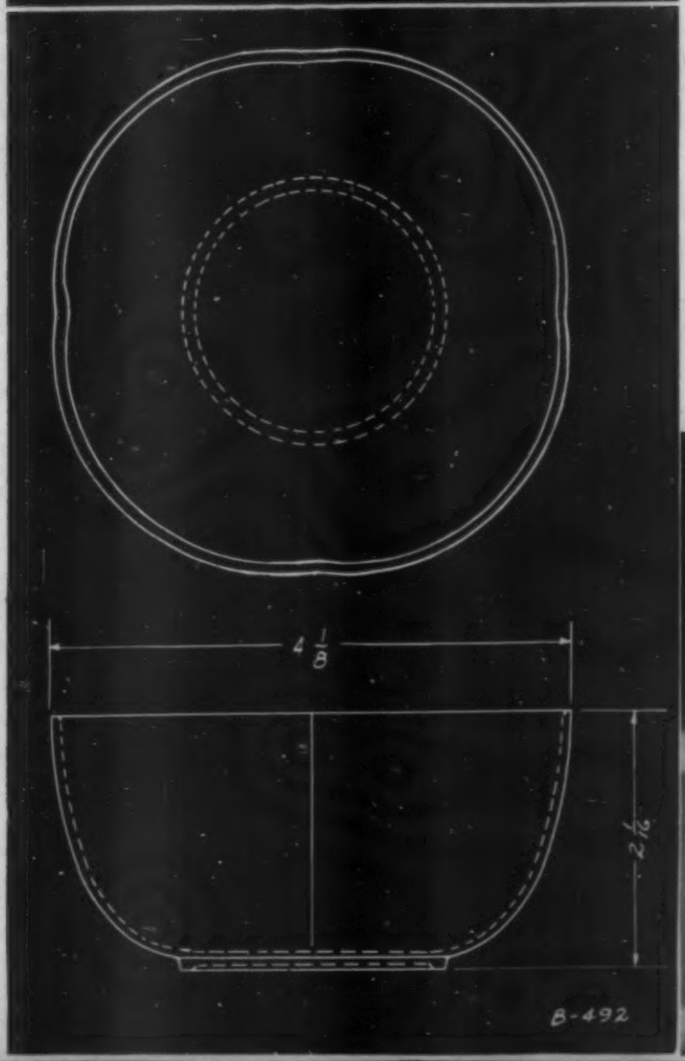
Can be produced in phenolic or urea



Cosmetic cream jar with screw top

B487-8

Made from phenolic giving a wide choice of colors



Finger bowl

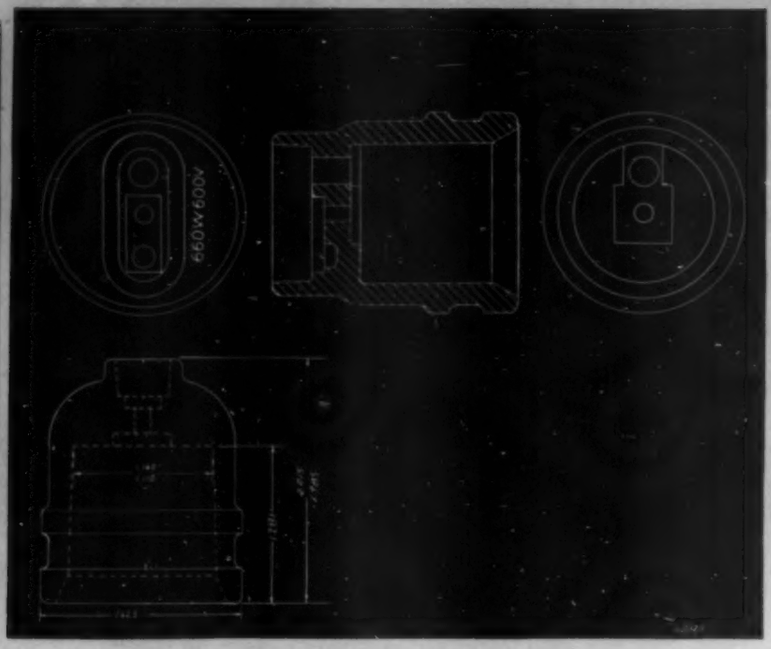
B492

Urea material

AMERICAN INSULATOR CORPORATION

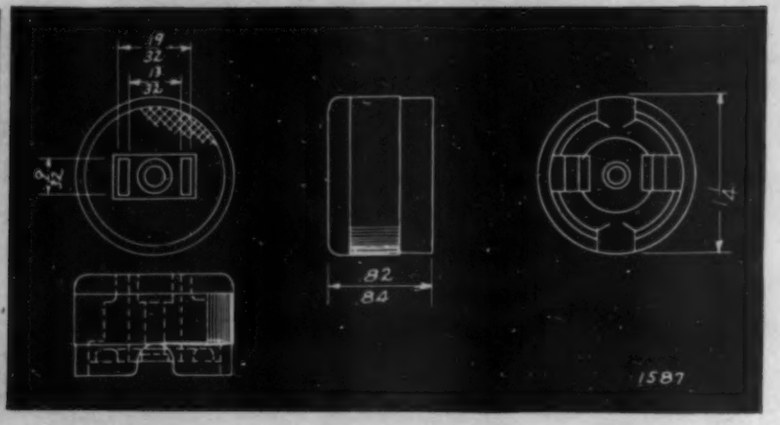
Weatherproof socket with shadeholder groove

1291 Cold molded composition



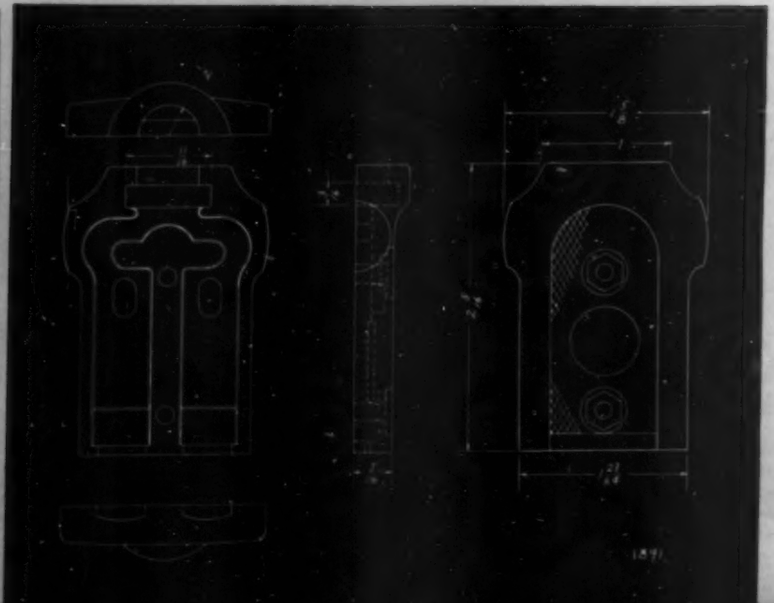
Receptacle body

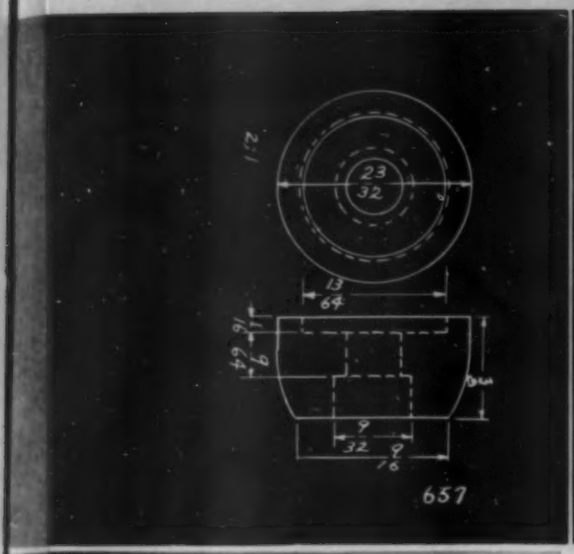
1587 Cold molded composition

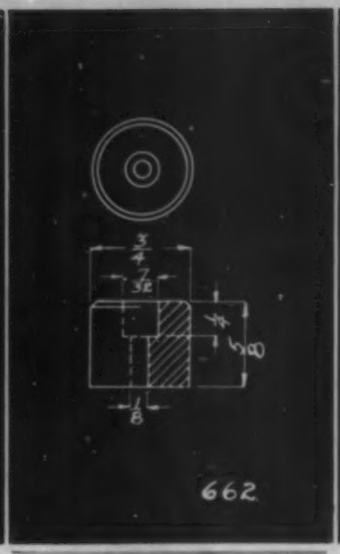


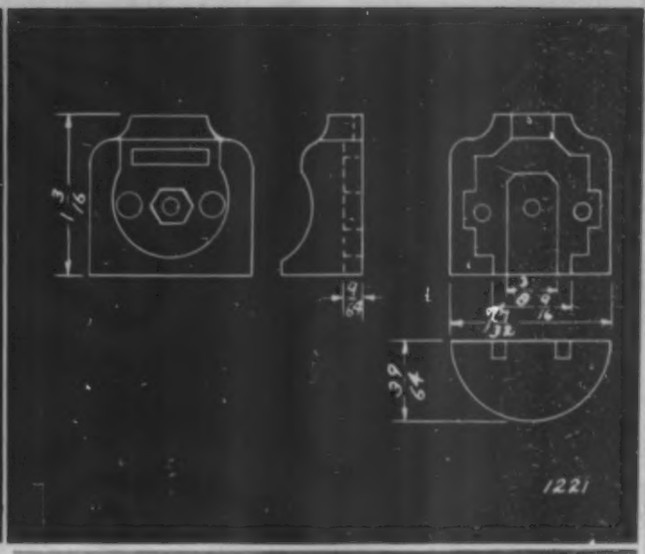
Connector plug

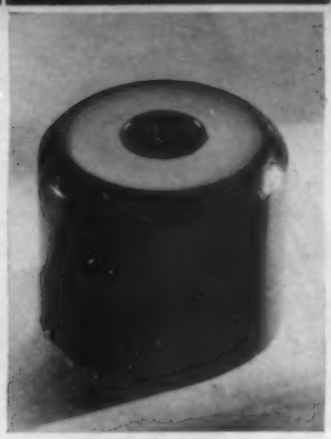
1891 Cold molded material

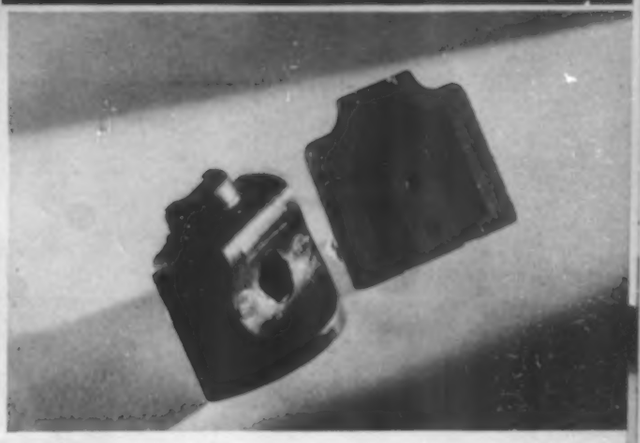












Foot for bottom of household grill

657

Cold molded material

Foot for sterilizer or other appliance where heat insulation is required

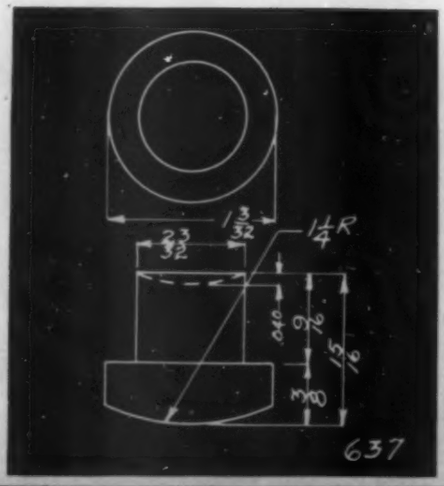
662

Cold molded material

Extension connector casing

1221

Cold molded composition



Push button

637

Cold molded material

AICO

Cold molding

BY ERIC BEACH*

To the layman, trade-marked plastic materials of the thermosetting and thermoplastic groups, are today as familiar as porcelain, Pyrex, linoleum and other household equipment materials. But brand names applied to that group known as cold molded plastics find recognition limited for the most part to designing and specification engineers and to purchasing agents in the industrial field.

It is not to be inferred, however, that cold molded products have no application in the home. In fact, the more heat resisting types of connector plugs for flat irons, and many other parts of wiring devices and electrical appliances are made of cold molded plastics. Other household applications may be noted, such as radiator valve wheels, knobs for pot lids, heat resisting handles and fittings of various kinds. While performing their humble functions efficiently and well, cold molded plastics lay no claim to the general utility and artistic attributes earned by hot molded plastics by virtue of bright colors, brilliant finishes, and adaptation to a multitude of household and industrial uses. Cold molded plastics serve a different field.

Rarely does one find a cold molded piece exposed to view and offered as an integral part of a decorative effect. But look at the third rail supports deep down in a subway, examine the insulation block inside of a safety switch cabinet, delve into the internal workings of elevators, telegraph systems, or wherever apparatus is set up for the generation and distribution of electrical current, and there will be found cold molded plastics defying the destructive arcs and intense heat to which they are constantly subjected.

Having originated in the electrical industry it is only natural that 95 per cent of the present demand for cold molded products still remains electrical. These products have been busy keeping pace with that fast growing industry and do not possess some of those characteristics which have enabled hot molded plastics to reach into so many other fields substituting for wood, metal and other construction materials. It is true that phenol-formaldehyde and urea plastics have displaced cold molding to a large extent in the smaller forms of wiring devices.

With the recent stimulation in industrial activity, however, comes a renewed interest and demand for cold molded plastics. Many are the uses for which they are eminently fitted and for which no satisfactory and economical substitute has been discovered. A review, therefore, of the materials and processes of manufacture, of cold molded plastics is interesting.

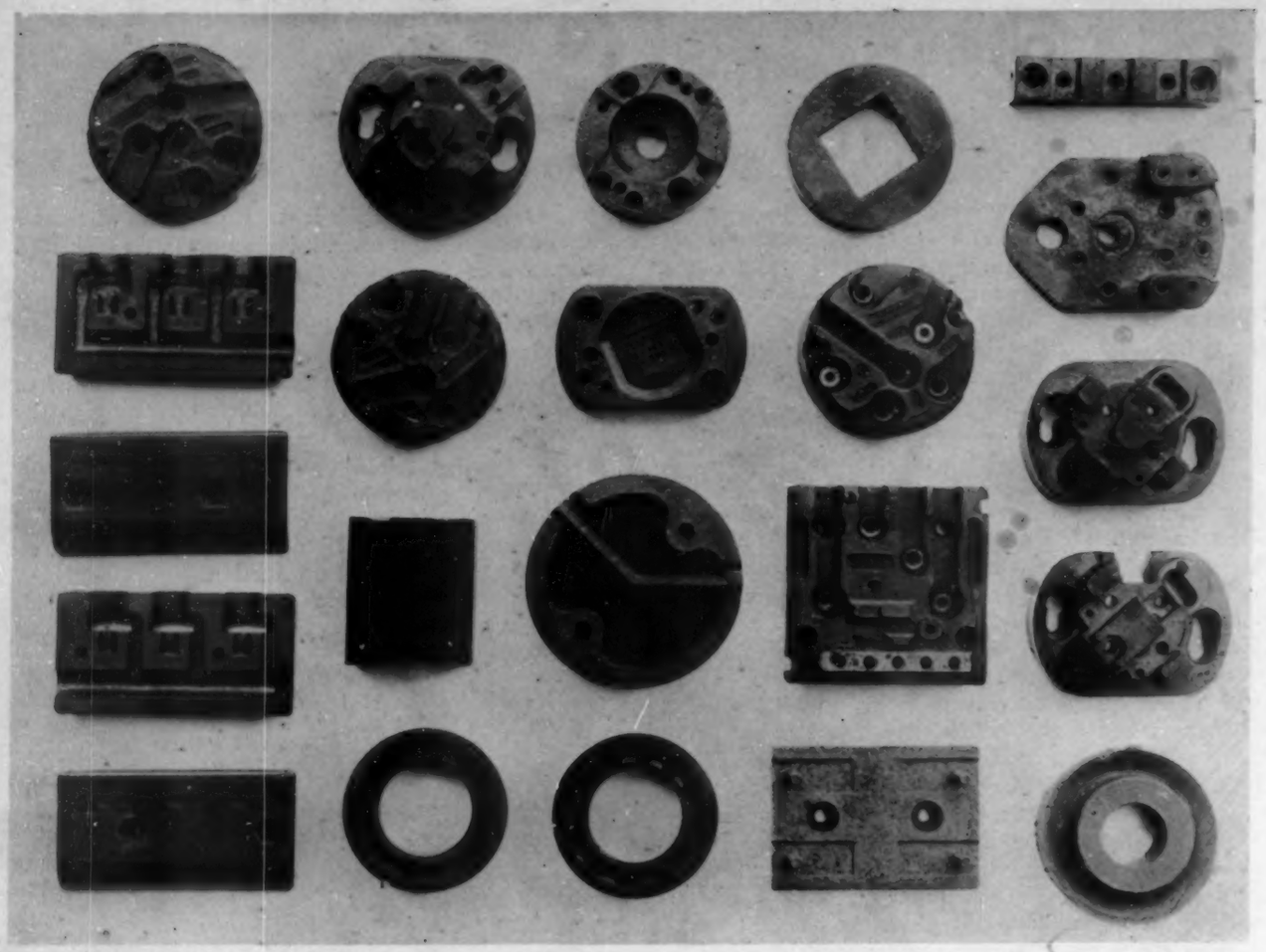
Broadly speaking cold molded plastics may be divided into two main groups, organic and inorganic. Asbestos, a form of fibrous mineral and generally used as a filler, is common to both groups. Therefore, the distinction, it must be understood, applies to the binder which is mixed with the filler when compounding the molding powder. To illustrate: A mix consisting of asbestos and pitch is termed organic whereas a mix of asbestos and cement is inorganic. As each cold molder manufactures his own molding powders according to his private formulae, which is quite the opposite to the practice in the hot molding industry, several variations result within the above general classifications, but these are not numerous because of the comparatively few cold molders operating in the industry.

Cold molded plastics are distinguished for their comparatively high heat resistance, moisture resistance and dielectric values. Also, where quantities of molded parts required are small there is great economy effected in mold costs and production.

The purpose for which the molded material is needed largely determines the choice of an organic or

Three-piece switch box molded by The Plastics Division of General Electric. Although a cold molded material is used for greater insulation values, close tolerances are maintained

* Salesmanager, Garfield Manufacturing Co.



Electrical parts of cold molded plastics by Cutler-Hammer Mfg. Co., which may well be called "cold molded insulation"

inorganic mix. For wiring devices of low current capacity and for non-electrical heat resisting articles where great strength is not essential, organic mixes usually are selected. Black and brown are standard colors although through the use of special binders and pigments it is possible to produce several conservative shades of colors, such as reds and greens. Usually, however, either strength or heat resistance must be sacrificed to some extent in obtaining colors other than black or brown. In all cases the degree of finish is a matter of polishing, which being a separate operation adds to the cost. When a material is specified which must be arc resisting or must stand high heat, then an inorganic mix is needed. Most of these are gray in color except where they have been impregnated to increase water resistance, in which case they are either black or slate color depending upon the impregnating agent. Occasionally, specifications clearly indicate an organic mix but call for additional mechanical strength. In such cases it is up to the ingenuity of the molder to develop a special mix, having the desired characteristics.

Again for certain types of moldings a glossy surface is desirable at the least possible finishing cost. By varying the nature of the binder or filler and their proportions it is possible to obtain a much better natural finish from the mold, but care must be exercised in the baking not to ruin the finish by too high a baking temperature. To obtain a good natural finish there must be a high proportion of binder compounded with finely divided filler. But this means sacrificing strength and heat resistance for appearance. Likewise, referring to inorganic mixes, frequently a specification calls for high arc resistance and low water absorption. The best arc resistance is found in a natural inorganic molded piece, but to obtain the specified degree of water resistance calls for treatment by impregnation. All materials discovered to date for such treatment tend to lessen the arc resistance, so the cold molder is constantly placed on his mettle to maintain a balance of properties in his mixes and a uniformity in his processes if he is to meet and maintain specifications.

With the exception of varying methods and materials so outlined above, the process of cold molding is similar in all cold molding plants. Both organic and inorganic mixes are pressed cold in hydraulic presses ranging from 5 ton to 500 ton pressure capacity depending largely upon the size of the piece. When moldings are small and tolerances liberal, speed in the pressing operation may be acquired through a volumetric feed arrangement, but often if the piece is

Refers to Tegit, a product of Garfield Mfg. Co.

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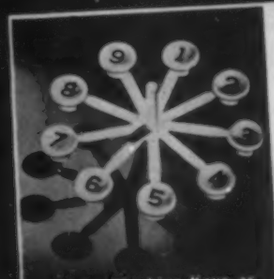
Injection Molded PLASTICS

Erie has developed and perfected the molding of plastic frames around spherical glass in one operation.

Radio and automobile dashboard knobs are made lighter, cost less by using a thin-wall construction. A design feature pioneered by Erie.

All articles shown on this page are molded of Tenite.



Adding Machine Keys as they are ejected from the mold with gate and runners attached.

Formerly fabricated of celluloid, this resistance indicating chart is not only more attractive with its unusual depth of color and raised lettering but is also sturdier and more durable.

By specializing exclusively in injection molding, Erie is unfettered with outmoded molding practices and has a thorough understanding of the advantages and possibilities of this newest development in the plastic industry.

Practical proof of this is evidenced in the many articles successfully molded by Erie that formerly had to be either fabricated or machined, or that were impossible to be made of plastics at all.

Numerous, too, are the Erie Plastic pieces that have presented no particularly difficult engineering problems, yet are outstanding for the quality they reflect with their added depth and richness of color and their cleaner, finer finished appearance.

And buyers of plastics are further served by the opportunity to call on the ability and experience of the Erie art and design staff. This group, which is headed by a nationally recognized industrial design artist will, without obligation, submit sketches on restyling existing products or execute new ideas from the first rough sketch to the finished design.

A battery of automatic injection molding machines of both the hydraulic and mechanical types have sufficient capacity to maintain the high Erie standards of quality and workmanship even when meeting the largest production demands.

Write for your copy of "The Newest Thing in Plastics". It will tell you in more detail why more and more manufacturers are having their parts "Injection Molded by Erie".

This 3" tuning dial is molded of Tenite for the Colonial Radio Co.

Added color for the home... Erie Injection Molded Door Knobs.

Housewives like the color and warmth of these Erie plastic butcher knife handles.

Isaac Walton wasn't fortunate in having Erie Plastic Reel Handles. Formerly machined, now molded.

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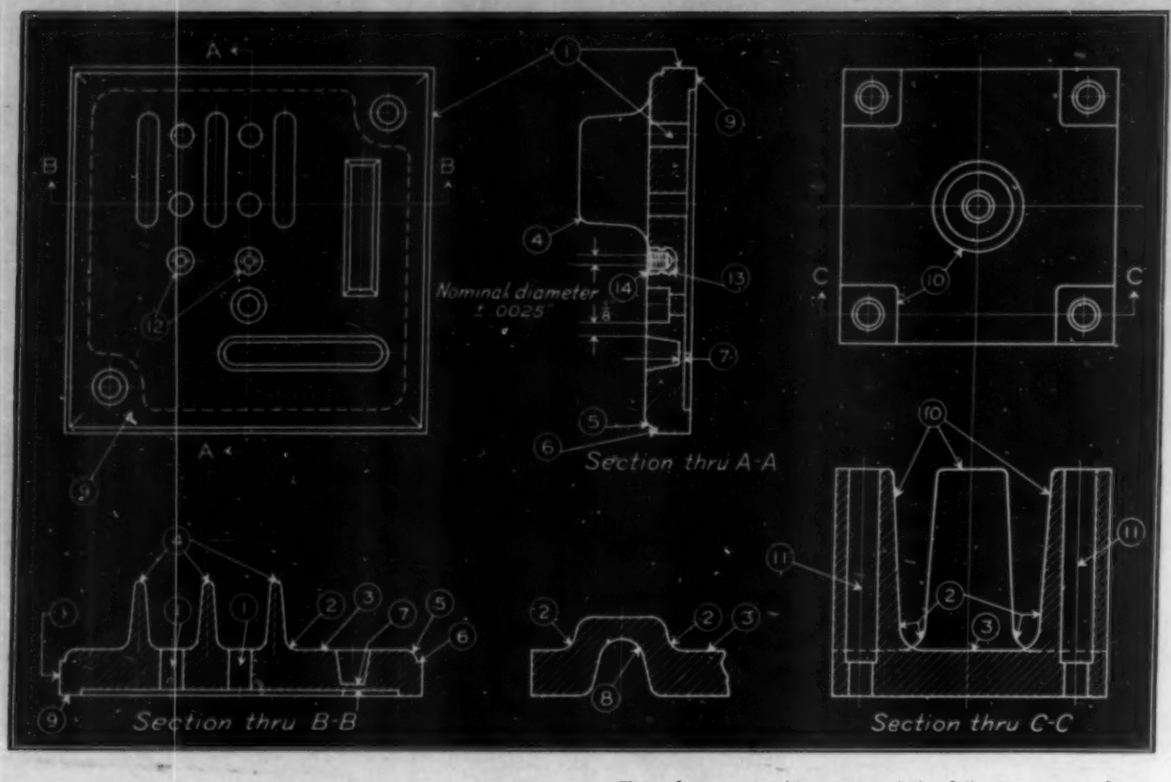


The references in this page and the following page refer to this chart which is shown by courtesy of the Garfield Mfg. Co.

fairly large or close tolerances are demanded the amount of powder required is carefully handweighed for each pressing operation. During the pressing operation metal inserts are added if required.

From this point on the process of manufacture for organic material differs from that for inorganic material. The former is baked in gas or electric ovens at graduated temperatures, for a specified number of hours, depending upon the finish, hardness, toughness or other characteristics desired for the particular piece. At the end of the bake and when the molded pieces have cooled off they are ready for the finishing process. Burrs and flash are removed, grinding to tolerance is done and the degree of polish added that is required. Wire brushes suffice for a rough polish, but where a high finish is specified the parts are usually sanded and then buffed. In the case of inorganic material the parts are steam or water cured, and then the moisture is dried out. Finishing is as above except no polishing is done. Following this comes the impregnating for moisture resistance if called for, and then a short drying process.

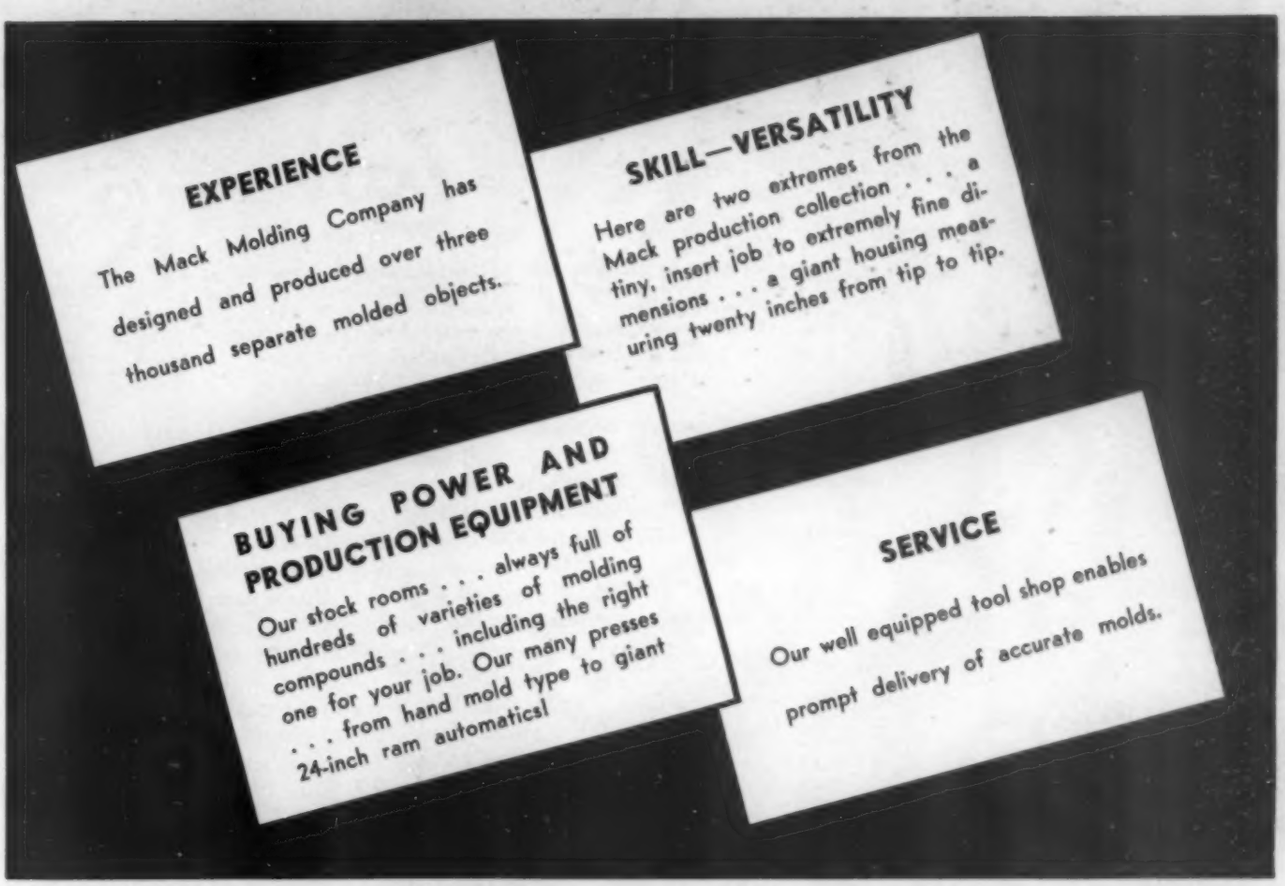
Whether interested in hot molding or in cold molding all divisions of the industry have one thing in common, and that is the mold itself. The mold is the matrix from which are delivered innumerable reproductions of one object, more alike than peas in a pod. In fact, a customer would not accept molded parts if they possessed the variations in size and shape as are found in a single pod of peas. They must be exactly alike, and the degree of likeness maintained depends to considerable extent upon the mold itself. The single cavity mold employed for cold molding would seem to present less difficulty than the multi-cavity mold required for hot molding processes. That is true to some extent. Less steel is needed and less time required for the construction of the mold. But consider for a moment the materials that are to be pressed in the mold. Mold wear with thermoplastic and thermosetting materials is negligible, whereas in cold molding the asbestos, cement and some other materials used are all abrasives and it takes a good piece of steel to withstand the constant abrasion to which it is subjected under pressures far greater than usually employed in hot molding. At best, fifty to a hundred thousand operations on a small press will send the mold back to the die shop for repairs. While molding of most parts for industrial uses does not run into such large quantities, tolerances are generally very close and pins used for forming holes in the molded parts frequently have to be renewed.

For the consideration of engineers who may be engaged in designing apparatus requiring cold molded insulation the following suggestions are offered. Drawings to represent typical parts are used as examples.

Draft is desirable on all walls, except the outer periphery of the piece and on through holes (1). Generous fillets (2) in corners should be employed

Ask Yourself This Vital Question

"WHAT DO I WANT IN A MOLDER?"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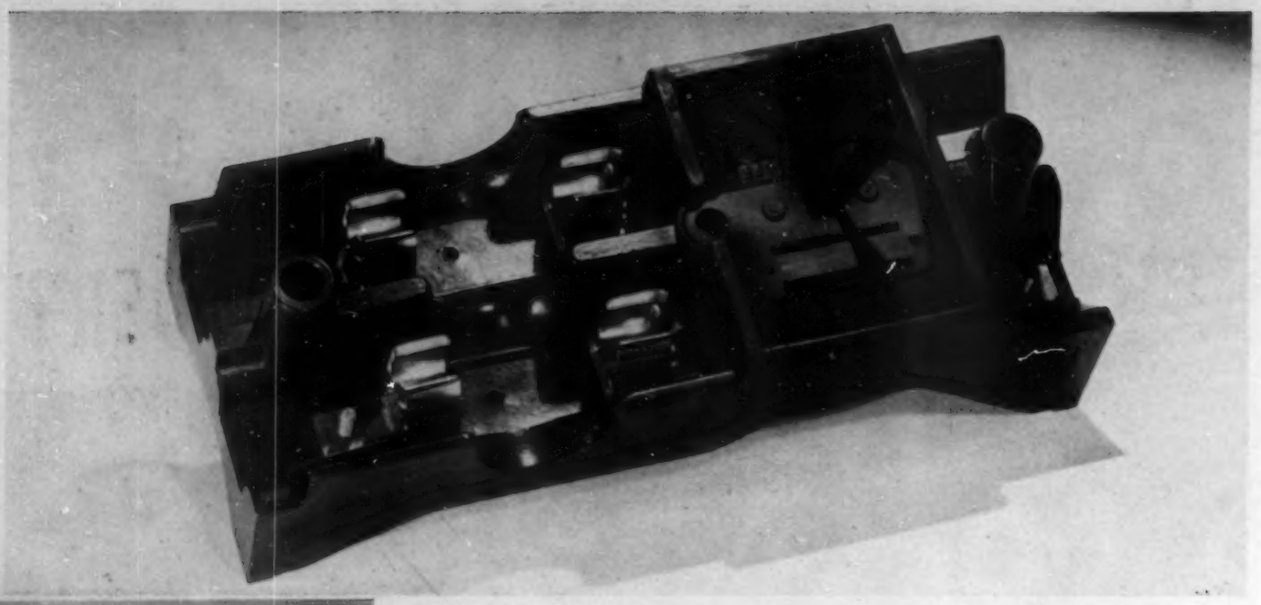

Above—Fused switch base molded by Garfield Manufacturing Co. using an organic mix. Assembled by Frank Adam Company, St. Louis. Left—Third rail insulator molded from inorganic mix for I. R. T. subway system by Garfield Manufacturing Co. Shown mounted on base and supporting section of third rail

where possible, and are essential where high thin walls join heavier sections (3). Round corners and edges (4) improve the appearance of fins and barriers, and materially assist in the molding operations. Where round corners (5) are desired on the periphery of the piece, a small straight step (6) should be placed at the beginning of the radius on the vertical plane.

Thin wall sections between counter-bored holes, depressions and outside walls should be avoided. Generally, ⅛ in. of material should be provided. Cross holes, i.e., holes at right angles to the vertical plane must be of large diameter if they are of considerable length, to insure strength in the pins making them.

Thin sections (7) in the horizontal plane cause excessive mold wear, and are subject to blisters. Arch-shaped sections (8) are subject to relatively large warpage, and should be avoided, if possible.

Where two pieces are to be assembled together, the surfaces should be ground, therefore, no projections should rise above mating surfaces. Surfaces intended to be mounted against flat or machined surfaces should be ground. To facilitate grinding and improve the appearance of the part, grinding bands or pads (9) are to be placed around the edges and mounting screw holes.

High, small projections (10) tend to distort from the vertical plane, and when mounting screws are to pass through these projections, the holes should be enlarged (11) through the greater length of the projection.

Inserts—Where screw anchorages are required, metal inserts (12) must be used. These inserts must be free from grease, solvents, loose chips, fins and burrs. Poor inserts are decidedly harmful, especially those having fins and burrs which cut the press operators' fingers, with the resultant slower production and higher cost of the finished article. The holes in the inserts must be of uniform diameters within plus or minus .0025 deg. tolerance, to avoid getting composition in the threads. Insert walls must be thick enough to withstand heavy pressures without crushing. Where blind holes are used, the closed end should be chamfered considerably (13). Chamfering the open end (14) facilitates materially the assembling of other parts.

In conclusion, while cold molding has its limitations with respect to finish within reasonable cost, and its application is largely confined to industrial purposes, electrical for the most part, it has its definite advantages. These are heat resistance, arc resistance, low water absorption, good dielectric value, excellent strength, and low mold cost. All of these qualities command the attention of the designing engineer.

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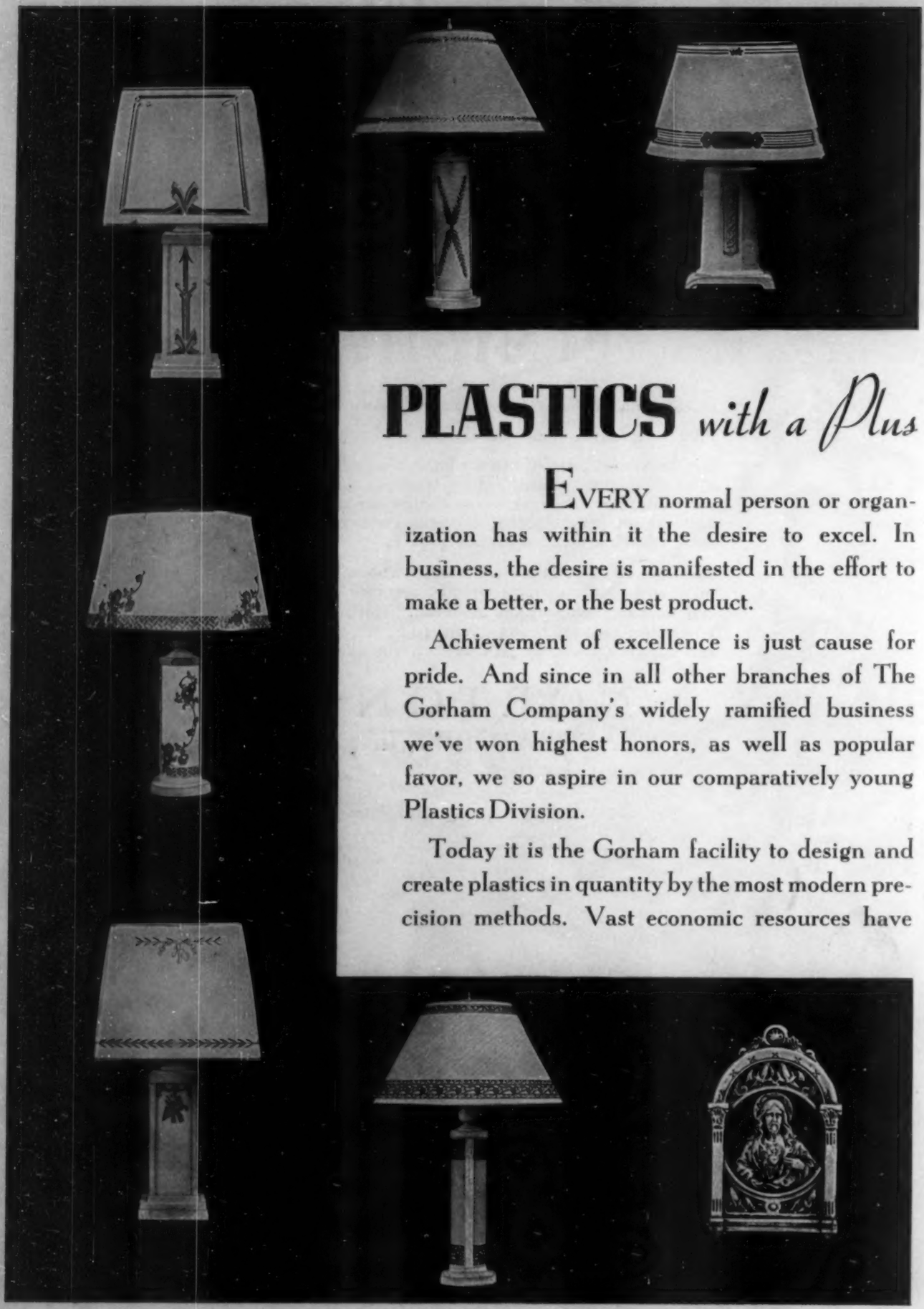

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EVERY normal person or organization has within it the desire to excel. In business, the desire is manifested in the effort to make a better, or the best product.

Achievement of excellence is just cause for pride. And since in all other branches of The Gorham Company's widely ramified business we've won highest honors, as well as popular favor, we so aspire in our comparatively young Plastics Division.

Today it is the Gorham facility to design and create plastics in quantity by the most modern precision methods. Vast economic resources have

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May we be pardoned, therefore, for expressing our pride in what we sincerely believe to be one of the best manned and equipped Plastic producing plants in America. Quite naturally we would be most happy to receive your consideration and an opportunity to bid on your very next order.

The Gorham Company

PLASTICS DIVISION

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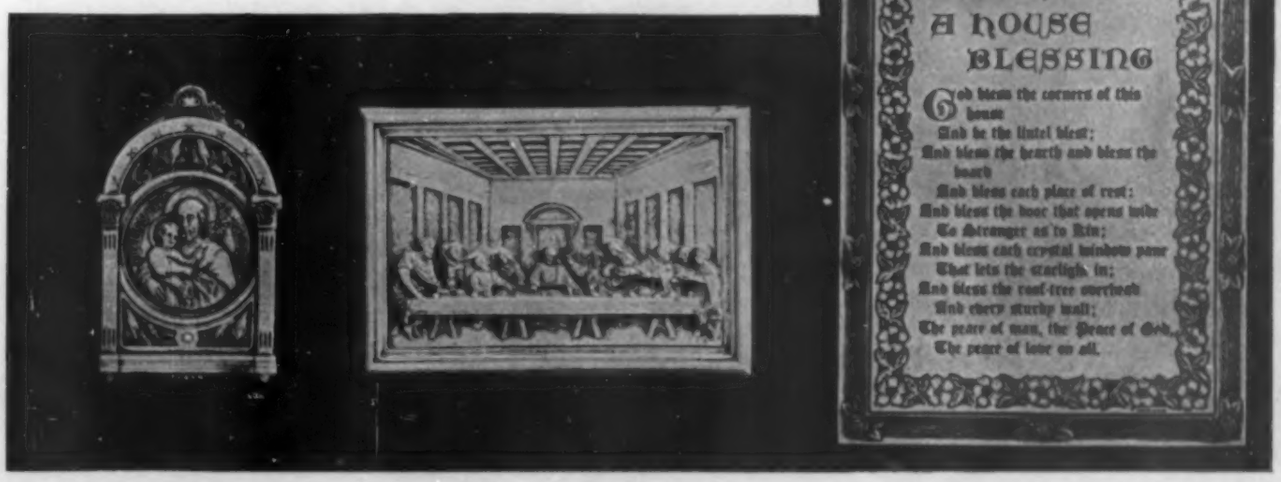
PROVIDENCE, RHODE ISLAND


A HOUSE BLESSING
God bless the corners of this house
And be the lintel blest;
And bless the hearth and bless the board
And bless each place of rest;
And bless the door that opens wide
To stranger as to kin;
And bless each crystal window pane
That lets the starlight in;
And bless the roof-tree overhead
And every sturdy wall;
The peace of man, the Peace of God,
The peace of love on all.

BAKELITE-ROGERS

Two examples of textile parts produced from a combination of molding material and resin blanks

Resin boards and blanks

BY N. D. HANSON[1] AND S. M. SILVERSTEIN[2]

RESIN boards and blanks are made by combining various types and quantities of resin and fibers on paper making equipment to produce both laminating and molding boards of unusual strength—combined with many other desirable characteristics. These materials cover the wide range from relatively slow setting (polymerizing) laminating boards which can be used for decorative, punching and electrical insulation applications—to blanks punched from fast curing molding boards, for special uses where molding materials do not have sufficient strength. Thus, the blanks for the molder are the equivalent of "preforms"—punched from boards made especially for molding—ready for direct loading and curing under the same general conditions as are used for standard molding powders. They may be used also in combination with molding compounds where the powder alone has insufficient strength for the application at hand.

[1] Bakelite Corporation. [2] Bakelite-Rogers Company, Inc.

Resin blanks have greater ability to flow in molding than has the treated paper ordinarily used for laminated structures. However, blanks that give an impact strength of from 10 to 15 foot pounds per inch square in the molded piece have decided limitations of flow and therefore they are not useful for making intricate molded shapes. These blanks are limited in use to reinforcing pieces made from regular molding material as well as for the production of flat, simple pieces where additional strength is required.

Resin boards for laminated

The boards for laminators are made on the same type of equipment as the molding boards for blanks, but the types of resinoid used are chosen to give base materials, in sheet form only, having characteristics which are entirely different from those required by the molder. Resin boards are, therefore, used as a base for the production of panels having character-

Products With a Future are Benefited by the Background of

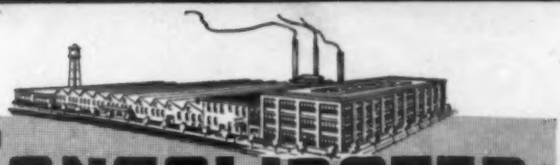
Consolidated
MOLDED PLASTICS

The ever-changing panorama of molded plastic applications clearly indicates the importance of selecting a molder with a keen knowledge of modern plastic requirements. More than fifty years experience in plastic molding is at your disposal when you name Consolidated Molded Products Corporation. Our staff of expert designers and precision molders have at their command complete equipment resources that assure you of obtaining unexcelled service. Your plastic molding needs will be speedily supplied by Consolidated, efficiently and economically.

The intricate plastic molded part, of many parts, (above) is an Electroac Mercury Switch for Globe Sprinkler Company.

The case (above) is for a new Seth Thomas Timer, and the housing (below) is used on Bethlehem-Doe Oil Burners.

Precision Molders in ALL *Plastic Materials*



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SCRANTON GB BUTTON — FOR 50 YEARS — GB BRAND

● *Formerly Molded Products Division of American Record Corp.* ●

General Offices and Factory : **SCRANTON, PA.** ▾ New York : Rochester : Chicago : Detroit : Cleveland

istics similar to laminated products manufactured from paper treated with resin varnish.

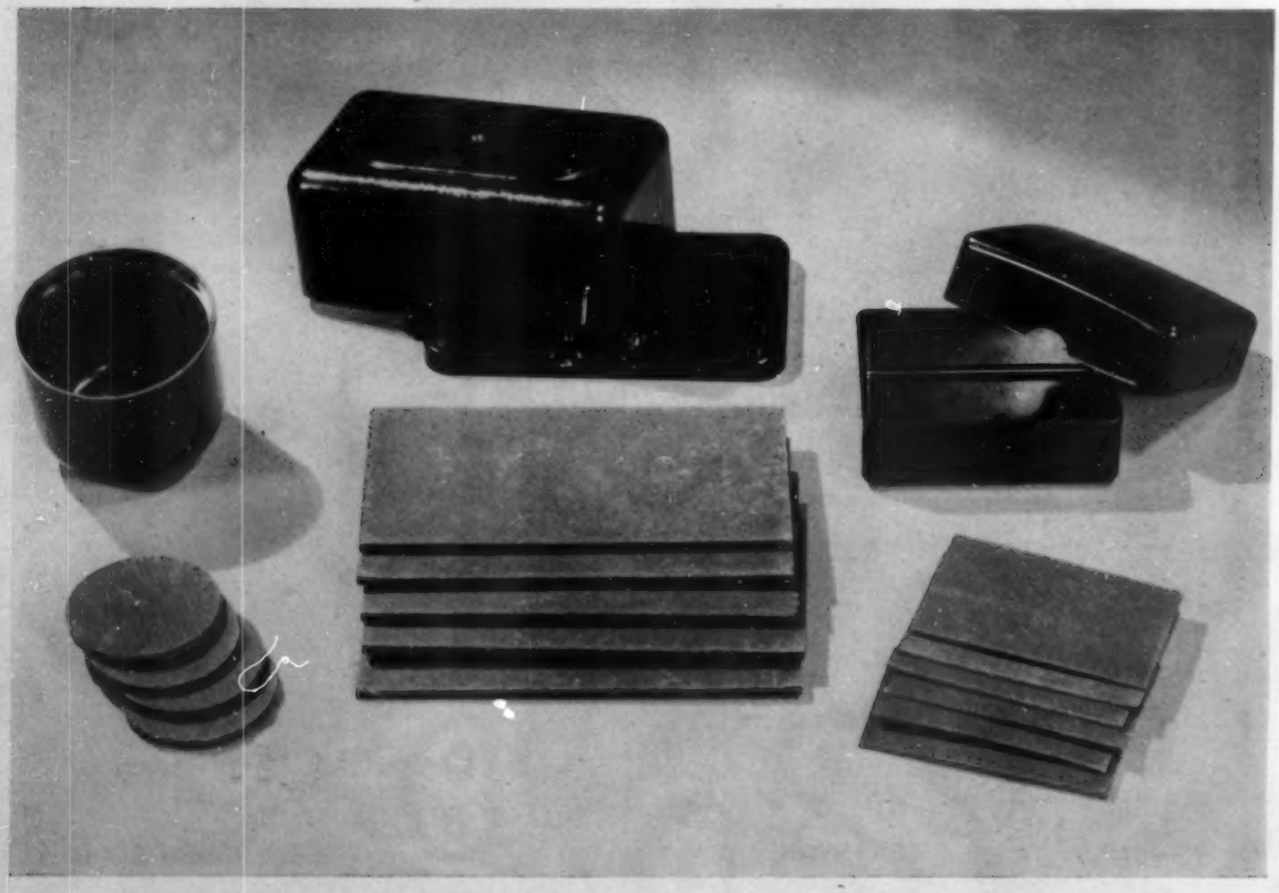
These boards are supplied to the laminator in sheets cut to exact size and of proper weight to mold the required thickness. Thus, the application must involve relatively large volume production of reasonably standard sizes and thicknesses. A single sheet of board faced with a thin sheet of treated surface paper on each side constitutes a simple three piece assembly, ready for pressing. Handling costs and time are reduced to a minimum since only three pieces are handled to a panel compared with the customary handling of two to six times as many thin sheets of impregnated paper. There is also an increased yield of saleable stock from the finished panels because of reduced cutting waste. The panels produced are hard and dense and can be sawed, machined, drilled and punched by the methods commonly used in fabricating some laminated materials. The pressing procedures range from steam temperatures of 30 to 120 lbs., hydraulic pressures of 1,000 to 2,000 lbs. per square inch, and curing cycles of 20 to 60 minutes, followed by cooling.

Resin blanks for moldings

By changing the resin characteristics from those normally associated with laminating varnishes to those of molding powders, molding boards are made and from these, blanks are punched to proper shape and weight ready for the mold. The uncured trim has a small rework value which is credited to the cost of the blanks. These blanks are designed to produce parts that have greater strength and impact resistance than can be obtained from general purpose cellulose-filled molding material.

The impact values for any one material, obtained by breaking ½ in. by ½ in. by 5 in. notched bars in the Izod machine, vary according to the method used in loading the mold and the general shape and dimensions of the blanks. This variation can be expressed in terms of energy to break from .32 to 1.2 foot pounds or from 4 to 15 foot pounds per inch square. When the fibrous structure is undisturbed during the molding, maximum impact values are obtained. When the mold is loaded with blanks which are 10% shorter than the molded piece, the material must travel at least 10% during the molding operation. In the latter case, the impact values are considerably less than when the normal laminated structure is undisturbed. Thus one grade, for example, has an impact strength of 15 foot pounds (energy to break 1.2 ft. lbs.) for an inch square in laminated form, but when it is caused to flow considerably in the mold the impact strength is reduced to 10 foot pounds (energy to break 0.8 ft. lbs.) per inch square. (*Continued on page 202*)

Resin-fiber blanks and the parts molded from them. From special types of blanks, parts of thin wall construction, or intricate shape can be produced, having good impact



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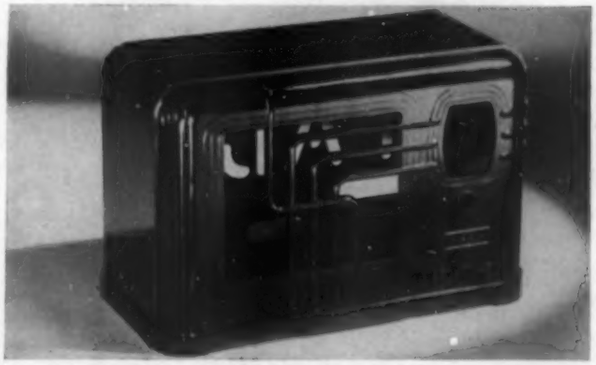

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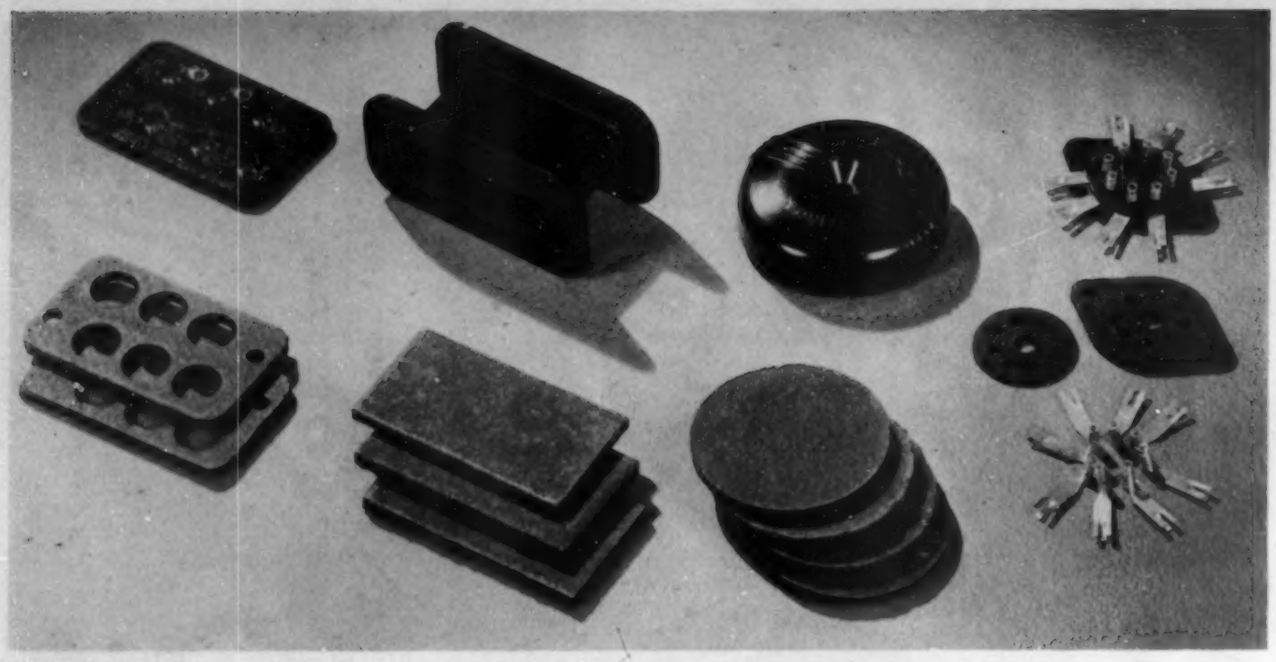

In the foreground above are blanks punched to approximate shapes. Behind them are the completed parts in which they are used.

Blanks can be used as "preforms" to make a complete molded piece or as an insert for reinforcing molding material or as a base for special surface finishes. The molding cycle varies from one to five minutes at 90-120 lbs. steam pressure and hydraulic pressures of 3,000-4,000 lbs. per square inch. Molded pieces may be pulled hot, but slight cooling improves finish.

Conditioning

These products are hygroscopic and respond readily to changes in atmospheric conditions, that is, they absorb or give off moisture, depending on the humidity conditions. It is, therefore, necessary to condition the boards before use. This operation must be carried out for proper performance even though the boards are conditioned just prior to shipping. Proper conditioning, baking the boards at approximately 150° F. from 30 to 60 minutes or the blanks from 2 to 30 minutes, promotes uniformity and reduces shrinkage. Excessive conditioning affects flow, finish and water absorption adversely. The proper conditioning cycle must be worked out depending on the humidity, the article to be molded and the desired results.

Grain direction

These products have a definite grain direction which is along the long dimension of a board or blank, unless otherwise specified. Where several thicknesses of boards or blanks are molded together in areas of more than one square inch, the grain direction of the assembly should be the same—for minimum warpage. The tensile strength is greatest parallel to the grain, while the resistance to impact is greatest at right angles to the grain.

The effect of grain should, therefore, be taken into account in the use of these products.

Shrinkage

Shrinkage is greater across the grain than in the grain direction. Shrinkage values vary between .0015 in. and .0035 in. per inch, depending on grain direction, type of flow and the dryness of the sample when molded. Other conditions being equal, minimum shrinkages are obtained by using blanks of the approximate size and shape of the molded piece. For instance, one type, with minimum flow, discharged hot, gives machine and cross machine shrinkage values of .0015 in. and .0025 in., respectively, but the corresponding shrinkages become more nearly equalized at .0030 in. and .0035 in. when the blank is made to flow considerably during molding. Thus the shrinkage differences due to grain direction are materially reduced, but their order of magnitude is increased under these extra flow conditions. The low shrinkage characteristics of the blanks permit their use with metal inserts.

Water resistance of molded blanks

The water resistance of molded pieces made from the average quality blank is generally equal to pieces molded from most molding materials. However, these values vary with the amount of conditioning before molding. For purposes of illustration, 1⅝ in. diameter blanks were molded in a 2 in. diameter disc handmold for five minutes with 100 lbs. steam. The mold was chilled for two minutes before discharging a ⅛ in. thick water absorption test piece and the mold heated for three minutes before reloading. The 24-hour water absorption values were as follows:

% Water Absorption—24 hrs.—2 in. discs—⅛ in. thick

	R117[3]	*R244*[3]	*R247*[3]
Not conditioned	0.33	0.45	0.41
Conditioned—10 min. @ 150° F.	0.33	0.34	0.40
Conditioned—60 min. @ 150° F.	0.35	0.45	0.30
Conditioned—10 min. @ 230° F.	0.45	0.45	0.40

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Thus each grade requires study to determine the best conditioning procedure for optimum water absorption values, consistent with other desired properties.

Humidity resistance of molded blanks

Tests made on R117, for example, molded in 6 inch squares, 1/8 in. thick, showed virtually no thickness change after 20 days at 90% relative humidity and 95°F. The area dimensional changes were definitely less along the grain than across the grain. In general, conditioning reduced the magnitude of the area changes but had an adverse effect on the appearance of the finish after 20 days.

Colors and special grades

Resin boards and blanks are produced in black. In some grades they are also available in brown and natural. Special characteristics, such as relative freedom from odor, resistance to wear (graphite base) and resistance to chemical action, can be obtained in both boards and blanks.

Fields of use

The following represents a partial list of actual and suggested applications for resin boards and blanks:

Resin Board—Laminated: Decorative wall panels, card table tops, bars, desk tops, display panels, cabinets, wainscoting, doors, baseboards. Refrigerator breaker strips and punching and electrical stock.

Resin Blanks—Molded: Refrigerator breaker strips, vegetable chiller trays, evaporator doors, bolts, handles, washers, striker noses. Utensil and tool handles, textile and wire spools, camera and instrument cases. Automobile door bumper shoes, striker plates, window handle bushings, steering wheels, window and body trim, instrument panels, sun visors. Telephone receivers, panels, bases, housings, fuse tubes, spools. Trays, boxes, helmets, globes, knobs, reproducing records, radio socket bases, buttons, resistors, radio cabinets. Rayon bucket covers and other applications requiring chemical resistance. Substitute for die castings, ceramics, chemical-treated fiber, wood, metal.

General specifications

Resin Board—Laminated

Sheet Sizes

Maximum width 50 in.

Maximum length 100 in.

Standard size 48 in. x 66 in., other sizes made or cut to order.

Molded Thickness

.025 in. to .145 in. (molded thickness at 1.35 density).

Greater thicknesses can be produced by molding together multiple layers.

Colors

Black is standard. Brown and natural also available in some grades.

Density

After molding 1.35. Uncured can be varied from 0.9 to 1.2, normally 1.0.

Bulk Factor

Approximately 1.35 to 1.00.

Resin Blanks—Molded

Sizes

Blanks are punched to proper shape and weight ready for the mold.

Molded Thickness

.025 in. to .145 in. (molded thickness at 1.35 density).

Greater thicknesses can be produced by molding together multiple layers.

Colors

Black is standard. Brown and natural also available in some grades.

Density

After molding 1.35. Uncured can be varied from 0.6 to 1.1, normally 0.9.

Bulk Factor

Approximately 1.35 to 0.90.

Table of properties

The following table is indicative of the properties of finished boards and blanks in various grades. Figures given under minimum and maximum do not represent a range in test data for a given sample, but are the extremes noted in extensive tests covering a wide range of samples and different grades.[3]

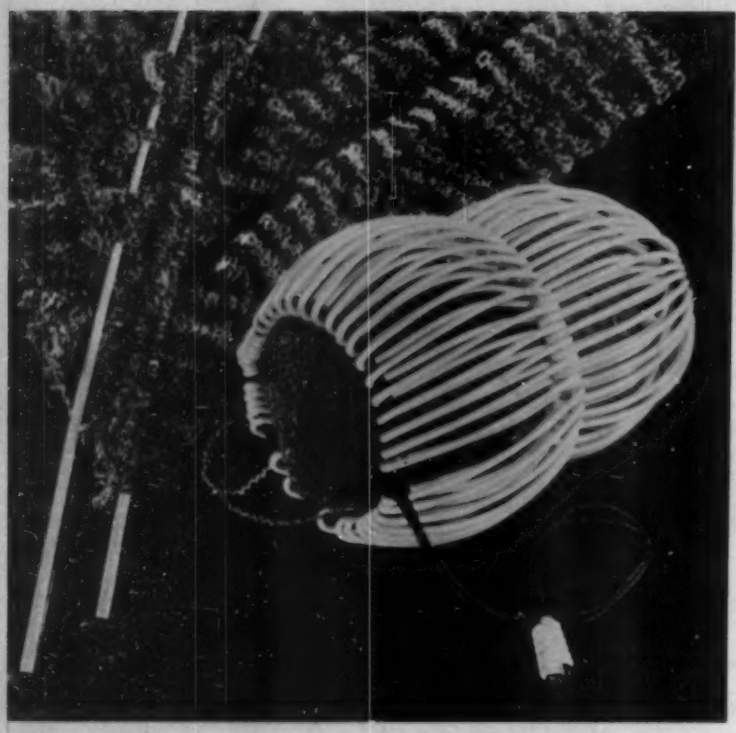
Physical Properties	*Minimum*	*Maximum*
Specific Gravity	1.32	1.41
Oil absorption	Nil	Nil
Water absorption (%—24 hr. immersion) (Water absorption varies, depending upon size, shape, etc., of sample)	0.2	4.0
Resistance to heat (safe limit for constant temp.)	90° C. / 194° F.	150° C. / 300° F.
Hardness (Sample flatwise)		
Brinell	30	40
Scleroscope	70	94
Tensile strength (ultimate) (pounds per sq. in.)	7,000	24,000
Modulus of elasticity (from tensile test) (lbs./sq. in.)	800,000	2,500,000
Flexural strength (transverse)		
Ultimate strength (lb./sq. in.)		
Sample flatwise	10,000	30,000
Sample edgewise	10,000	24,000
Compression test		
Ultimate strength (lb./sq. in.)		
Sample flatwise	25,000	43,000
Sample edgewise	13,000	25,000
Dielectric strength (volts per mil thickness)		
1/8 inch sample	200	600
1/32 inch sample	400	1,400
Dielectric constant	4.5	6
Power factor		
10^6 cycles	3.5	6.0
10^3 cycles	2.5	20.0
Volume resistivity (ohm centimeters)	10^{9}	10^{13}
Impact strength		
Energy to break test piece 1/2" x 1/2" with 0.1" notch in ft. lbs.	.8	2
$\frac{\text{(Energy to break test piece)}^4 \text{ ft. lbs. per in. sq.}}{bd^2}$	4	25

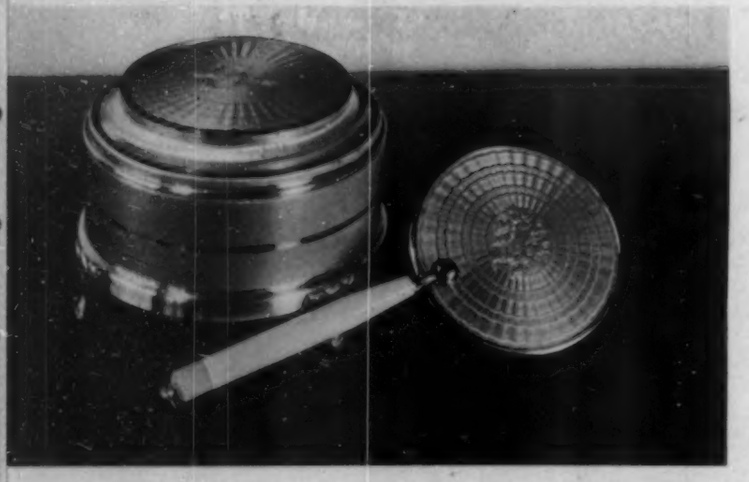
[3] Refers to B-R BLANKS

[4] b=width; d=thickness (measured in direction of force application)

Fabricating pyroxylins

BY ALAN F. RANDOLPH *





THE industry of synthetic plastics may properly be said to date from the experiments of John Wesley Hyatt in the United States and of Alexander Parkes in England, who, almost at the same time, demonstrated that a useful artificial material could be made with a base of pyroxylin. Now, nearly seventy years after the birth of these pyroxylin plastics, they are still going strong, in spite of the encroachments of numerous plastics of other types. In the United States four principal manufacturers produce, in addition to substantial quantities of the newer plastics, some fifteen million pounds per year of pyroxylin plastics under the trade-names "Pyralin," "Celluloid," "Fiberloid," "Nixonoid," and similar material is made in large quantities in Europe and in Japan.

Consisting essentially of cellulose nitrate and camphor, with suitable coloring ingredients, these plastics go to the trade in the forms of sheeting, rods and tubing. The pyroxylin plastics have established and held their place by virtue of a unique combination of useful properties. They may be made in an almost infinite variety of single and combined colors, ranging from a colorless transparent through translucent to opaque, possessing beauty in their own right or through the simulation of expensive natural substances such as ivory, tortoise shell, fine leathers and mother-of-pearl. They are light in weight, strong and tough, and readily adapted to a variety of methods of fabrication.

The great number of uses to which these plastics are now put is a far cry from the original purpose of

Above, at left—Knitting needles and yarn cage of pyroxylin beading. Below, at left—Pyroxylin is combined with metal in a charming powder box and mirror. The high chair, directly below, has a tray of pyroxylin, molded to shape, which is durable and easy to clean

* Plastics Department, E. I. du Pont de Nemours and Company.

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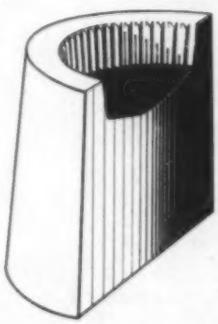

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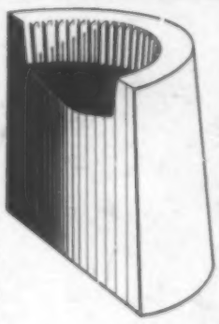

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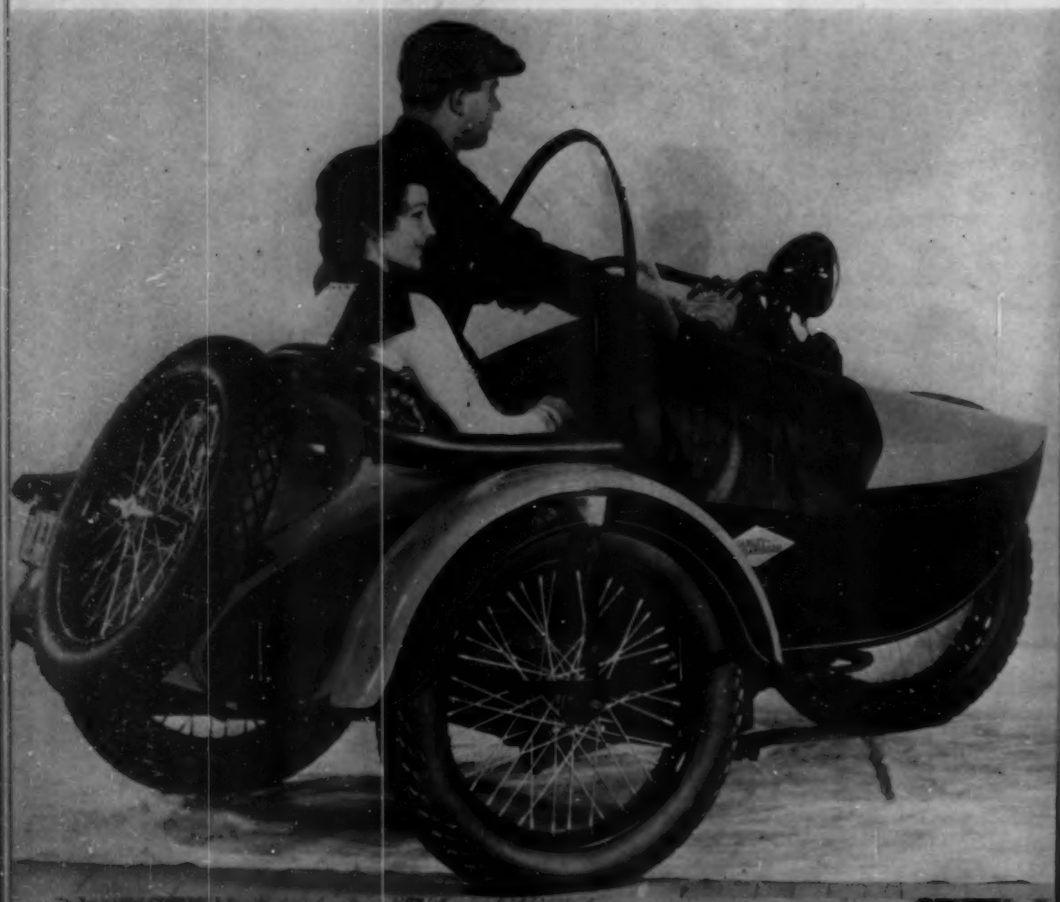
Hyatt's experiments, which were directed toward finding a substitute for ivory for billiard and pool balls, for which purpose, by the way, the material is not satisfactory. Some of the common uses of the pyroxylin plastics are of many years' standing. They are found beautiful, useful and durable in the form of combs, hairbrushes, mirrors and other items of toiletware, and similarly for toothbrushes and shaving brushes. They serve as handles for cutlery, tools, and so on, and as keys on adding machines, typewriters, pipe organs and pianos. The engineer uses them in his slide-rule and drawing instruments. Printed or lithographed they find widespread use in advertising novelties and in political campaign buttons. In games and sports they serve as pingpong balls, dominoes, dice, and in the construction of golf clubs, tennis racquets, polo mallets and fish-lures. Other staple uses have been for umbrella handles, knitting needles, thimbles, toys, buttons, buckles, hairpins, harness decorations, etc.

Other uses are of more recent development. The demand for safety in automobiles has, in the past ten years, made safety glass a necessity, and the pyroxylin

1



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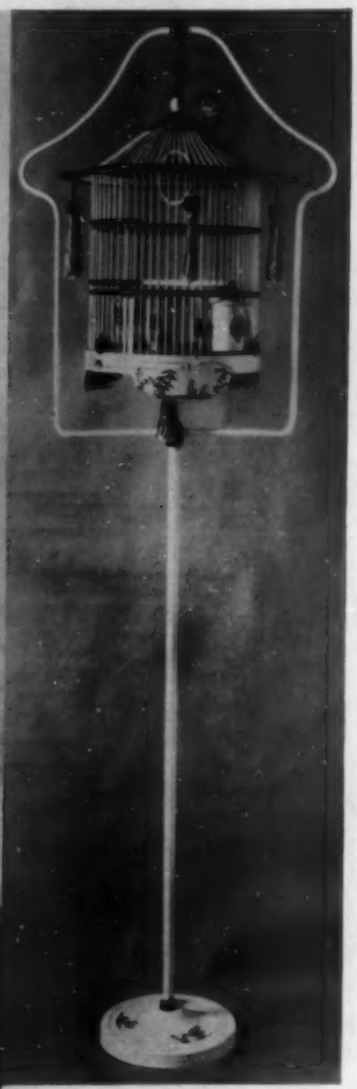
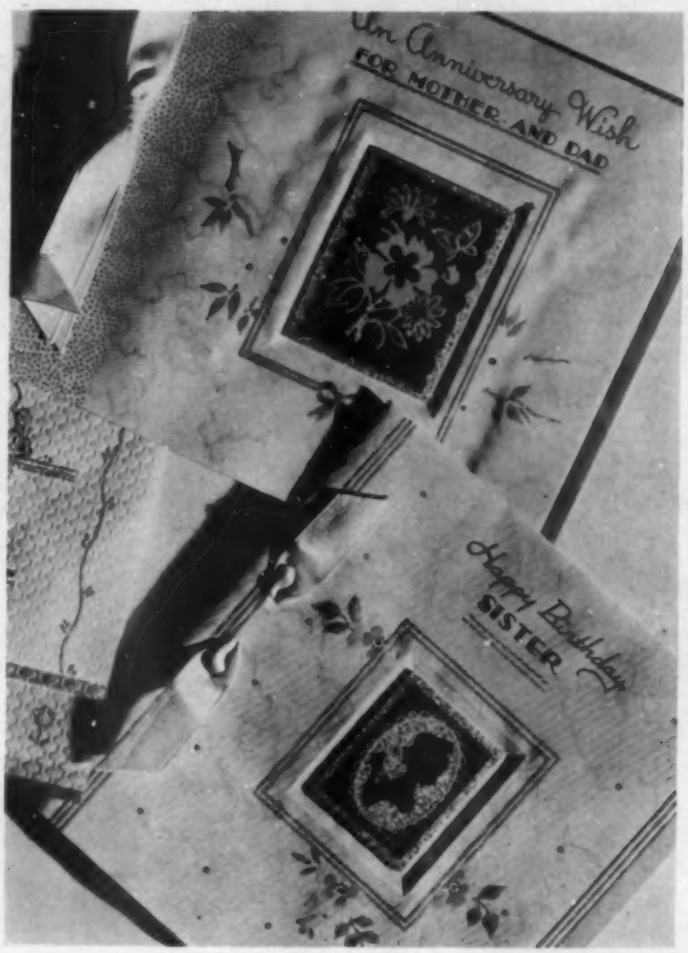


3

plastics, and, more recently, the cellulose acetate plastics, have become favored materials serving as the interlayer in safety glass, conferring upon it its characteristic toughness while preventing the scattering of glass in the event of a break. Also in comparatively recent years the traditional drab hard rubber has yielded to the superior strength and the brilliant coloration of the pyroxylin plastics for use in fountain pens and mechanical pencils; now, going one step further, fountain pens are made of this material in transparent form, which enables the user to see how much ink he



4

1. A thin sheet of transparent pyroxylin forms a clear nonshattering windshield on this motorcycle. 2. Bird cage made of pyroxylin plastic parts, fitted and cemented together. 3. The safety of modern transportation is enhanced by safety glass. 4. Decorated pyroxylin is used in greeting cards. (Photos, courtesy du Pont)

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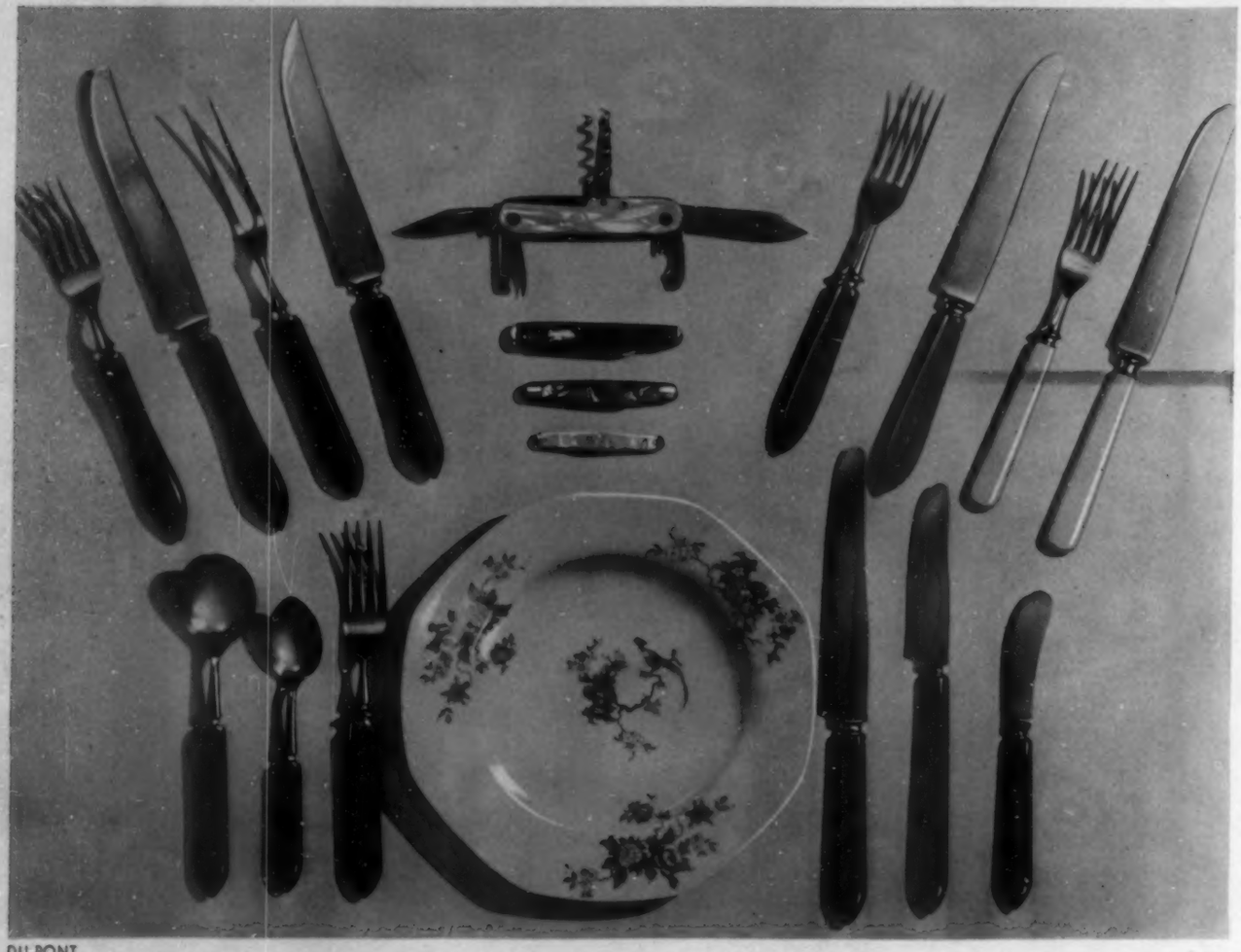

DU PONT

Pyroxylin is used in windshields, cockpit enclosures, landing lights and instrument panels of airplanes. It makes beautiful and durable cutlery handles as well

has left. The old-fashioned varnished toilet seat has almost disappeared in favor of one covered with smooth, attractive, sanitary pyroxylin plastic, and other bathroom fixtures and furniture, such as stools, hamper tops, towel bars, are made to match. The vulnerability of wrist watches has led to the adoption of unbreakable crystals of pyroxylin plastics. The lightness, smoothness and transparency of the material have found uses for it in accessories on airplanes. The shell-rimmed spectacles parodied by Harold Lloyd are widely used, and similar frames in more delicate colors are becoming popular. Cemented between layers of leather, the pyroxylin plastics help to make waterproof shoe soles and laminated power-transmission belting. As a covering for women's shoe heels the pyroxylin plastics, in finish and color to match the leather of the shoe, do not become scratched and scuffed like leather, and are more easily kept clean and presentable.

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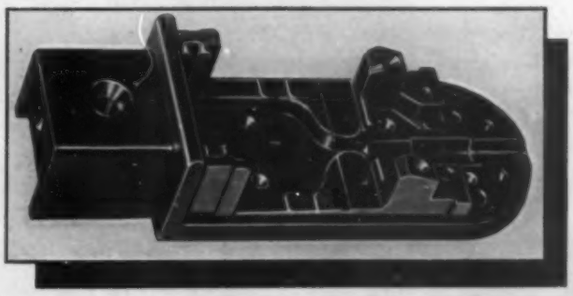

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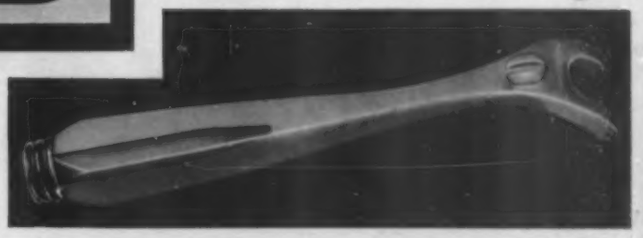

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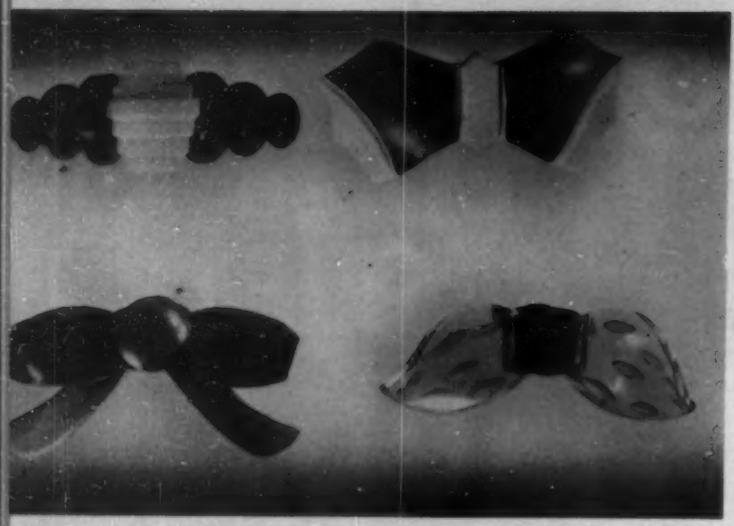

Carved and shaped, and combined with metals, a pyroxylin plastic makes smart shoe buckles

Pyroxylin covered heels are uncommonly tough and add weeks of service to new shoes without any sign of scuffing or cracking

The making of articles of so wide a variety of types naturally involves a considerable diversity of methods of fabrication. But practically all are merely variations of the two fundamental methods of shaping to which these plastics are particularly well suited, namely by the use of heat and pressure and by machining. The fact that these plastics are softened by heat, and may be shaped while thus softened, but regain their rigidity when cooled again, forms the basis for the operations of swaging, blowing and die-pressing.

Swaging is involved in making many thin-walled articles. A soap box, for example, is formed from a rectangular blank cut from sheeting. The blank is softened by being heated in boiling water or on a steam table and stretched into shape by the closing of a metal mold. The mold is ordinarily unheated, and is closed rapidly so as to shape the material before it has become too much chilled by contact with the metal. The article is removed from the mold as soon as this can be done without distortion, and is placed in water to complete its cooling.

The operation of blowing is analogous to swaging and also is applied to material in sheet form. The pressure of hot air or steam is used instead of the pressure of a metal plunger to stretch the sheet material into conformation with a concave mold. Thus in making floating toys two thin sheets of plastic are preheated and placed between two preheated metal plates containing matched half cavities, which are connected by a system of grooves leading from an entrance groove at one edge of the plates. The whole system is placed under hydraulic pressure and a tiny nozzle is inserted between the sheets at the entrance groove. Through this nozzle steam or hot air is forced between the sheets at all points where they are not held together in contact between the faces of the mold. This fluid pressure bellies out the sheets against the walls of the cavities to form the desired articles. Then the whole system is chilled.

A combination of swaging and blowing is involved in the formation of certain articles which cannot be formed by swaging alone, such as a circular container with shoulders. A plunger effects most of the vertical stretching and then steam is introduced through perforations in the plunger to swell the sheet out against the concave mold, which is of course split so that the article may be removed. Swaging and blowing are thus used for the production of thin-walled articles. Die-pressing is applied to massive articles, and involves merely the change in configuration of a massive blank of suitable size and of a simple shape as nearly as conveniently approximating that of the finished article. Thus toothbrush handles are made from pieces of the material cut to rods of proper length and width,

In making toilet seats, sheets of pyroxylin plastics are softened, stretched over the wooden form, and cemented into place

combs from rectangular blanks, dice from pieces of square rod. The blank is preheated to save time. The die must usually be heated and then cooled, although a few articles permit of the use of an unheated die. The article is removed from the die as soon as it is cool enough to hold its shape.

Pyroxylin plastics lend themselves beautifully to machining operations of all sorts—turning, planing, drilling, tapping, sawing, and so on. The material has no grain, like that of wood, but machines equally well in any direction, and being, of course, softer than metal, can be machined at a high rate of speed. Its toughness makes possible rapid machining without danger of cracking or splitting. Either with the hand tools of the home mechanic or with the high speed automatic or semi-automatic equipment of the large factory, pyroxylin plastics are extremely easy to work. Thus fountain pen barrels and caps are turned out rapidly and accurately by automatic turret lathes. Combs of the best quality are made by actually sawing out the material between the teeth. Brush blocks are drilled and the bristles inserted and fastened into the holes, all by automatic machinery. Scales for rulers and slide-rules are engraved by automatic machinery. The article, however made, is finally given a high polish by the use of rapidly rotating rag wheels supplied with mild fine abrasives.

By these simple techniques are made the majority of the almost innumerable articles to which the pyroxylin plastics impart utility, durability and beauty —beauty of color and pattern inherent in the material, beauty of form as created by modern industrial designers familiar with the capabilities of the material. Someone has stated that there are twenty-five thousand known uses of pyroxylin plastics. We haven't counted that far, but we do know that new uses are constantly being developed for these veterans among plastics.

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Abrasive cut-off saw cutting buckle slides from special stock. (Photos, courtesy American Catalin Corp.)

Machining cast resins

BY H. KREHBIEL*

TREMENDOUS growth in the use of cast resins during the past few years indicates that manufacturers of widely diversified products are becoming more thoroughly acquainted with the possibilities offered by these materials for decorative and industrial uses. Their choice of cast resin is influenced to a great extent by the ease with which it may be worked and by the unlimited range of colors possible to secure for individual decorative schemes. An even greater use may be anticipated when industry in general realizes the simple methods of fabrication required to produce finished articles.

Standard shapes of cast resin such as rods, sheets and tubes are usually available in stock sizes for immediate delivery. Special shapes, designed to require a minimum of machining and waste in fabrication, are cast to order and require from several days to two

* Sales manager, American Catalin Corporation

weeks for delivery. The number of standard shapes is constantly growing to include fluted, hexagon and other shapes of rods, etc. Special castings, such as clock shapes, rods with profiles suitable for jewelry fabrication and others are also available from stock. One company lists as stock patterns such items as cutlery and kitchen handle shapes, clock and instrument cases, automobile fittings, lamp parts, hardware, jewelry, etc.

Unlike inflammable plastics, no unusual provisions must be made for storing castings. They should be kept in a comparatively cool room at even temperature. Exposure to excessive heat and light should be avoided.

Jig, circular, hack or band saws can be used in shaping the pieces. Small pieces can be cut from rod stock or special shapes on abrasive cut-off saws or slicing machines. Speeds of twelve to thirteen hundred feet per minute are recommended for band saws. Fourteen to fifteen teeth to the inch and half-inch saw widths are advised for most work.

Drills similar to those used for brass work are recommended, ground as for cutting brass and with a generous feed. This allows chips to clear easily and avoids clogging the hole. For deep holes, twist drills with large flutes may be used and the drill should be lifted from the hole occasionally to remove chips. Non-alkaline cooling compounds may be used, though these are not absolutely essential.

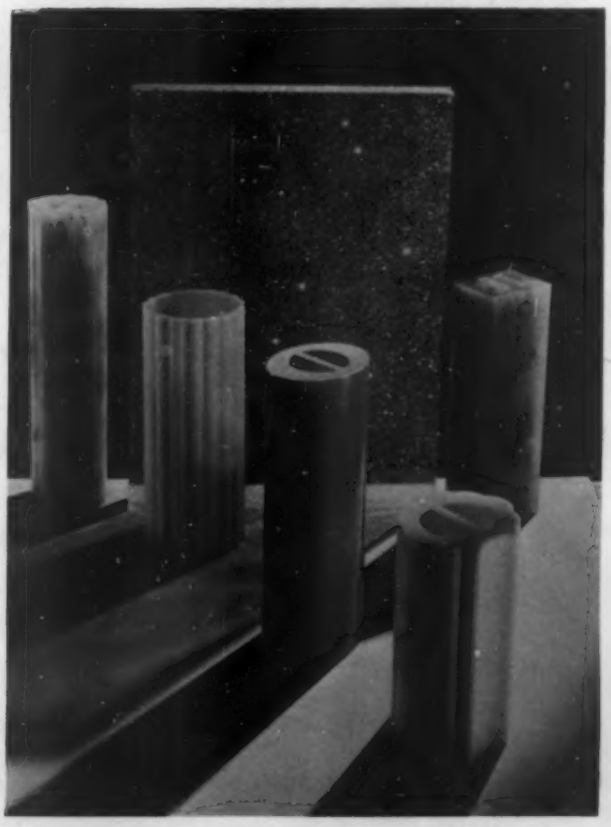

Fig. 1. Rods, tubes, buckle slides and sheet stock are cast in various sizes and shapes for jewelry fabrication

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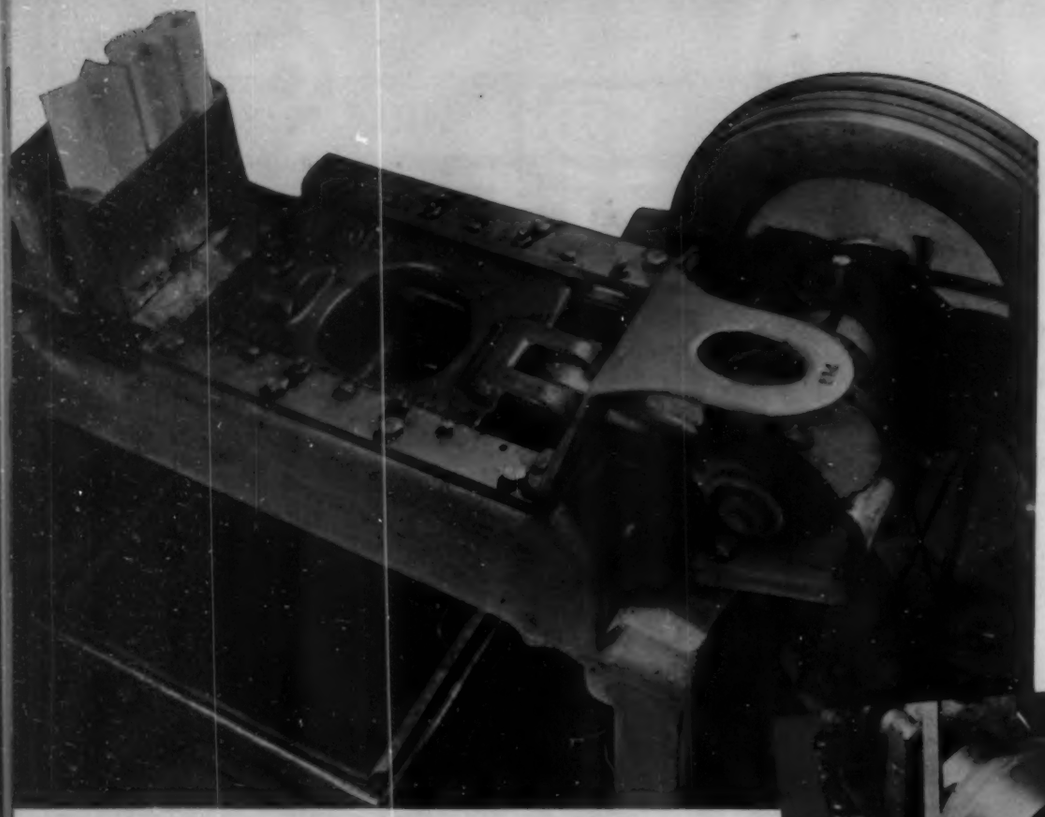

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Fig. 2. Top view of slicing machine with stock shapes of cast resin inserted ready for cutting. Guard is removed to show knife just entering the work. Fig. 3. Hollow-spindle lathe cutting one earring blank and shaping the next one at one operation. Fig. 4. Facing a brooch blank in a lathe. Blank is held by treadle-operated chuck while tool is carried on slide moved by operator's right hand

Standard taps and dies can be used to thread cast resins. Most makers advise the use of a cooling compound. Small holes, less than ten-thirty-seconds of an inch in diameter, can be used without threading by running the machine screw into the hole so that it cuts its own thread. This practice is not advocated for larger holes.

Much turning is avoided by the use of round castings. For shapes that cannot be achieved with rod or tube cross sections, lathes, milling machines and automatic screw machines may be used. Such parts as candlesticks, chessmen and other sections of irregular contour are often shaped on a wood-turning lathe. Straight and taper turning, boring and thread cutting are done on engine lathes. Speeds and feeds, as used for hard woods or brass, are recommended. In general, high speeds and light cuts produce the best results, cutting speeds ranging from 200 surface feet per minute upwards. While much work is done dry, makers advise a non-alkaline cooling compound for higher speeds. Ordinary cutting oil, free from caustic and soda ash, is generally used.

It is important that tools should be properly ground with a slightly negative rake and that they be set at or slightly below center. If tools are properly ground, chips will come off in a long ribbon. Overheating of the material should be avoided because of the possi-

4

bility of discoloration. Work can be held within limits as close as 0.001, but since some slight shrinkage usually occurs after machining, an allowance for shrinkage should be made where extreme accuracy is required. In most work, such care is not essential.

Carving, engraving or embossing is done in the same manner as with ivory, bone or wood, either by hand or with suitable machinery. Carving is often accomplished with small abrasive wheels turning at high speeds. These can be formed to make cuts of different sections. Fine rotary steel cutting tools are also used. On decorative work, such as jewelry, where hair-line accuracy in the location of cuts is not essential, the tool is often guided by hand. Some fabricators use special automatic milling machines to carve long runs of identical pieces at high speeds. Automatic screw machines are often used to turn out small parts in the same way that small metal parts are produced.

Cast resins polish to a high permanent luster. Rough cuts are usually ground, using the same type of equipment as required for wood or brass. Sand paper, garnet paper, belts or fine abrasive wheels are used. For most work, a generous supply of water is recommended, when wheels are used, to prevent overheating and to keep the wheel clean.

Surfaces which show tool or grinding marks are given a smooth surface, preparatory to final polishing by "ashing," in which an ordinary buffing wheel, made of muslin discs, of twelve to fourteen inch diameter, is used. Wet pumice, kept in a shallow pan under the wheel so that the buff just touches it, is used as a polishing agent. Often, additional wet pumice taken from the trough is applied by hand or trowel above the piece being worked. Polishing is usually done on larger pieces by a second wheel using bar wax or specially prepared polishing compounds. These wheels, usually twelve inches in diameter, operate around 1800 r.p.m. A third clean dry wheel is used to give a final polish.

For large quantities of small and medium size pieces, tumbling is often employed. Here, barrels of hard wood, lined with leather or heavy felt and oper-

Fig. 5. Ashing parts with wet pumice on muslin wheels. Polishing is done on similar wheels, but dry

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Fig. 6. Portion of tumbling department showing double-deck tumbling units in the background. Fig. 7. Applying findings to the backs of clips and pins. Shanks are forced into holes by this toggle press which is foot-operated

6

Top—Candlesticks and similar objects of irregular contour are shaped on a wood-turning lathe. Below—Flat surfaces are smoothed on a sanding belt before polishing

7

ating at about fifty r.p.m. are used. Solutions vary with the article being polished, a common procedure calling for preliminary tumbling in dry pumice, to which wooden shoe pegs or similar agents have been added to provide friction. The pumice is later washed off and a second tumbling follows in damp hard-wood sawdust. Other materials are sometimes used instead of pumice.

Smooth surfaced pieces can be cemented together readily, providing a waterproof and tight joint. Various types of cement are recommended by suppliers for different types of work. A certain degree of softening can be obtained by submersing the resin pieces in

Top—Tubes and rods of cast resin may be cut with an ordinary band saw. Below —The first step in polishing a cast resin ball on a three wheel machine

water for a few minutes at 150 to 180 degrees. When so softened, moderate shaping operations can be performed simply. After bending the piece should be cooled in the form. Cold water may be used to speed cooling when production requires it.

In forming cutlery handles and similar pieces, it is often desired to attach these firmly to a metal shank. For this purpose, a hole, slightly smaller than the shank, is drilled and the piece is then immersed in hot water until sufficiently pliant to permit placing over the shank or stud. In cooling, it shrinks on tightly and subsequent application of similar heat will not affect the joint sufficiently to loosen it in ordinary use.

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Color molding and its requirements

BY N. S. STODDARD*

NEW trends in modern design, instigated by the consumer's demand for colors in pleasing combinations, have hastened the increase of color molding so that over a period of two years the production of color molding compounds has more than tripled.

Among the most important and most widely used materials for colored plastics at the present time are those of the urea type. These materials which use a colorless resin as a binder, can be molded in any color including pure white and the most delicate pastel shades. Because the resins are colorless it is only a matter of blending the correct shade of pigment with the right color for a particular application. They are unlike the phenolic type of materials which use an amber colored resin. In phenolics, colors are available, but only in dull shades of red, green, brown, etc., which darken with age and exposure to sunlight. The urea materials retain their colors permanently.

The biggest enemy of urea materials is dirt. It is one thing that both the raw material supplier and the molder must constantly guard against. It is perhaps a greater problem for the molder than for the raw material supplier because in the molding operation the compounds are exposed to contamination from the moment the drum is opened until the mold is closed, whereas, with the raw material supplier the manufacturing process and blending operations keep the compounds unexposed to air and dust from the beginning to the filling of drums for shipment. Of course, the raw material supplier must be sure his drums are clean inside. To assure this, most compound manufacturers use enameled-lined drums.

With modern molders, air conditioning is playing an important part. Purification of air has been one of the major weapons which molders of colored plastics use to combat dirt. The facilities for color molding of one large molder exemplify the precautions taken by molders to assure the customer of plastic parts in delicate shades that are free from particles of dirt and other impurities. Let us take a short trip through this color molding plant and learn what is done to keep equipment, compounds and molds free from contamination.

First, we notice that the color operations are separated from the usual run-of-molding in black and brown. Such an arrangement eliminates the possibilities of a playful breeze blowing any loose dark compounds into the lighter shades. As we look down the long molding room we observe a section which is partitioned off and totally enclosed. In this room the drums of molding compound are opened and each loading of compound for the press is weighed and placed into specially constructed bags (free from lint). These bags are then sealed and removed to the scene of the molding operation—not to be opened until the mold cavity has been prepared.

Although the loading room is fed with filtered air, air conditioning is most important in the molding room. If the mold cavity is not absolutely clean when the sealed bag is opened and the compound is poured into the mold, the precautions taken in the loading will have been for naught. Therefore, conditioned air free from impurities must be released into the room at a velocity that will not blow the molding powders around, but adequate for cooling and breathing. After each piece is removed from the mold, the cavity must be cleaned spotless before the next batch of compound is poured in. This cavity cleaning requires the use of compressed air to remove stray pieces of flash left by the previous operation, and a wiper (lint free) to cleanse the corners and uneven contours of the cavity of any foreign particles. With careful execution of these precautions plus full knowledge of molding technique, it is only a matter of loading and closing the press for molding.

At the beginning of this article we stated that the use of color molding materials had more than tripled during the past two years. In addition to the benefit of molded color, there are many other reasons for this rapid increase in use, reasons which are inherent in the materials' properties and in the development of new molding facilities. For instance, all colors are homogeneous—complete impregnation of pigments—and the finish is permanent. Many manufacturers have found this one asset of great help. It answers their problems of surface finishes on casings and housings made of other materials that chip, peel or become dull and drab looking. They know that their products will indefinitely retain a lustrous finish and fine appearance when they use plastics.

Then there is always the benefit of simplified design which is provided by combining the electrical and mechanical properties in one part. Here again the manufacturers secure advantages over the use of other materials—such advantages as fewer parts required, reduced assembly costs and increased production.

Another important factor is the lightness in weight of the materials. Less than the weight of aluminum, these materials reduce the weight of the finished product which results in a substantial saving in shipping cost.

New molding facilities and molding techniques have added materially to the increase of molded color. For example, the year old development of large-unit molding which has opened a new field for plastic parts, larger than heretofore had been possible. Some of the most noteworthy large-unit parts so far produced are housings for scales, coffee grinders and meat choppers, also large lighting reflectors. Other developments in raw materials, mold making and molding technique are making the road to increased sales and greater profits easier to travel for the progressive manufacturer who must keep abreast of the ever changing modes and demands of the consumer.

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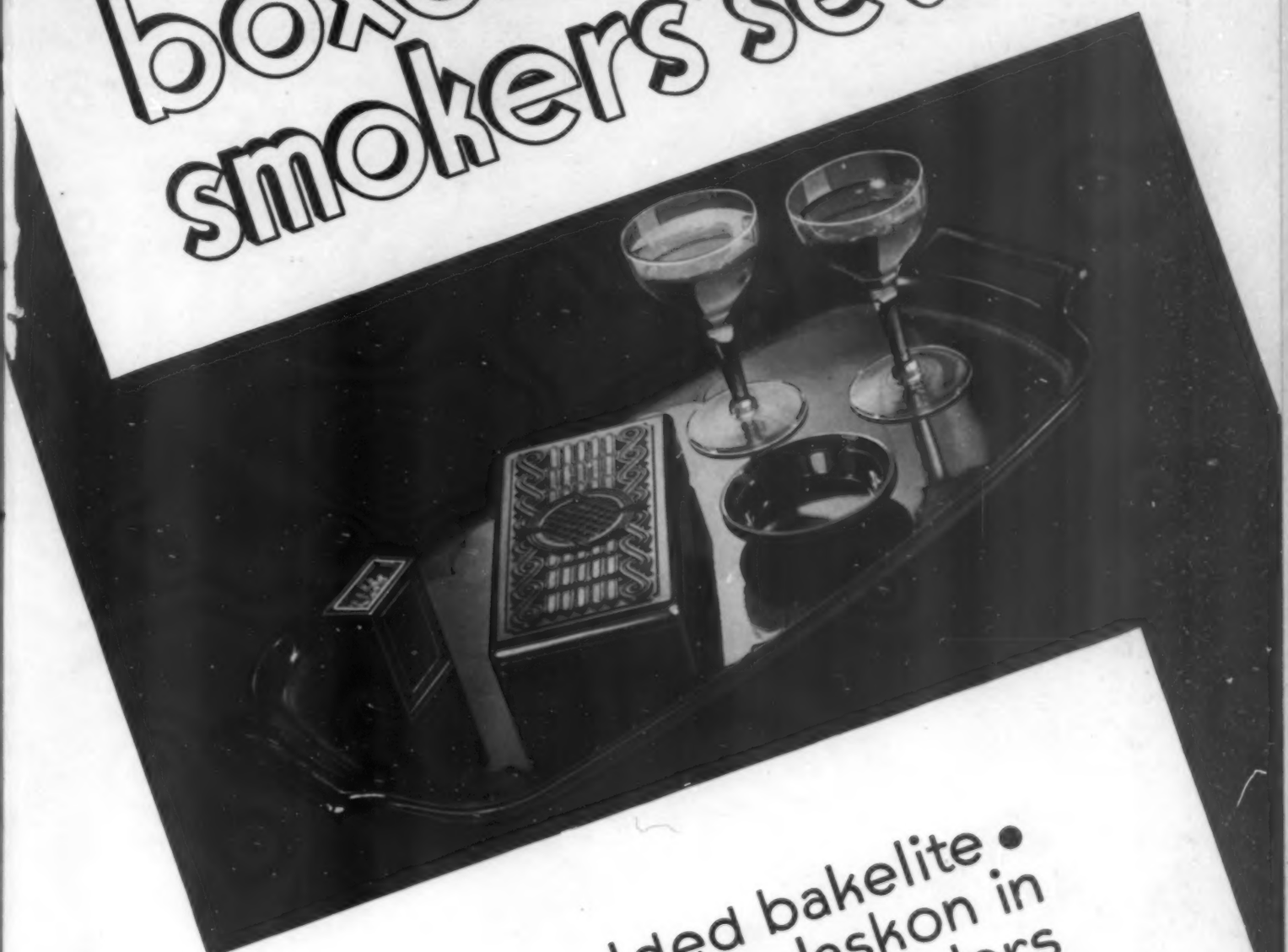

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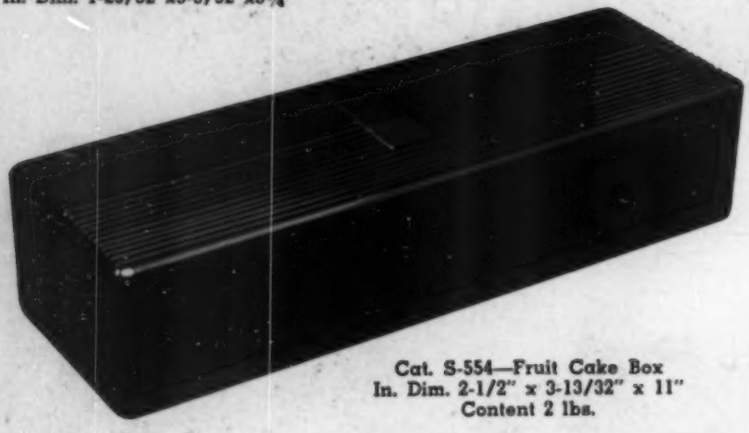

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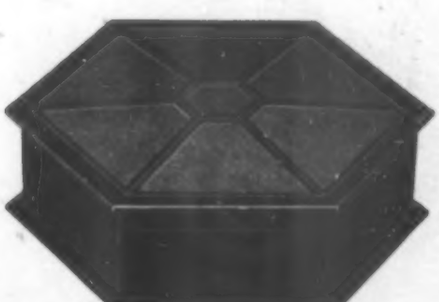

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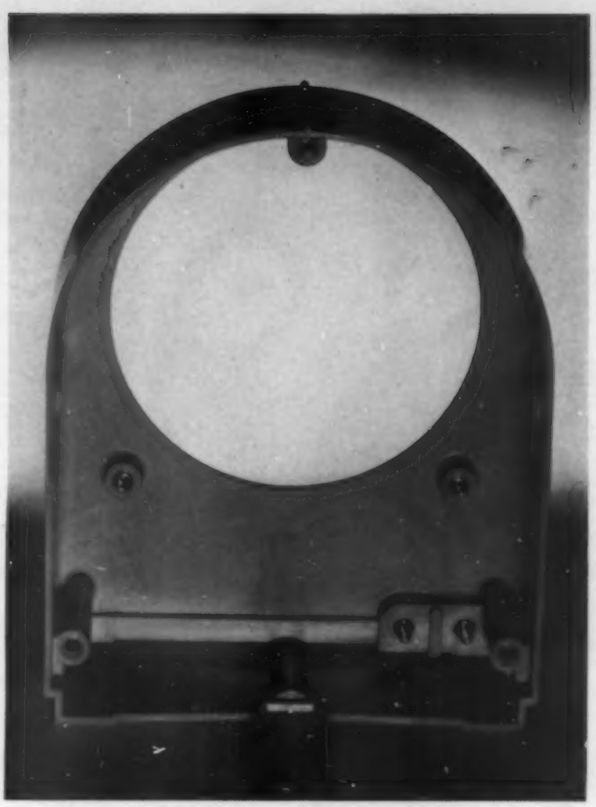
Inserts for molding

(Continued from page 142)



Interior of a clock case in which inserts have been molded in place, ready to attach the works with a minimum of assembly cost

Generally speaking, inserts when employed properly make possible the introduction of many new ideas in plastics. Careful consideration should be given to their application, bearing in mind there is a difference in thermal expansion between most materials and plastics. This is an important part to consider in the original design. Inserts can be shrunk to fit in molded pieces after the pieces are ejected from the mold and also can be assembled to the finished piece after they have cooled to room temperature. Inlays for decorative work can be molded in position. Rivets and eyelets often facilitate assembly operations and these should be carefully specified. Complicated insert moldings where the phenolic types of materials are required should be done by extrusion molding in order to eliminate distortion which might take place in the pressure type of molding.

These varied references, together with descriptions of the metallic-drive and self-tapping inserts which appear elsewhere, indicate rather closely the methods employed to make assembly economical. Inserts of one sort or another take on considerable importance when it is considered that once molded in they are immovable. Their proper placement by prearranged designed specification becomes an important item of original planning and the merits of the different kinds of inserts available should be frankly discussed with your molder before specifications are finally complete.

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Designing for plastics

(Continued from page 111) sharp highlights and one-thirty-second or three-sixty-fourths is almost the maximum that should be used on any medium-sized molding. Ribs or flutes need be raised very little above the surface to catch the necessary light and give a rich effect. It is better to be oversubtle than overbold in surface decoration. In other words, if you use bas-relief, make it very "bas." (Fig. 5.)

Remember, too, that bas-relief on the piece you are designing is much cheaper than the reverse, *i.e.*, intaglio. For instance, if your design calls for a floral pattern, raised lettering or what not, the mold-maker obtains his flat surfaces by machining, then carves the design in intaglio in the steel mold, the resultant molded piece being in relief. But if you ask him for intaglio on the *finished* piece, then he must begin with the highest point of relief in your design, cutting away from that to the flat surfaces, a difficult procedure, and largely a hand job. (Fig. 6.)

In spite of the greater difficulty of producing finished molded pieces with intaglio designs, there has recently been an increasing tendency toward the use of surface design formed by sharply incised lines, which, when the molding is finished and buffed, are then rubbed in with contrasting colors. Some excellent effects can be obtained in this way, and this style of decoration can be used in combination with relief or intaglio. White, silver or gold paints may be used with black or other dark colors, and black, brown, red or other paints with the light-colored plastics. Make sure, however, that the cut-in lines which are to receive the color are very narrow; better that they should not be wider than one-thirty-second of an inch; otherwise the operator, after the paint is daubed over the surface and then wiped off, will wipe the paint out of the lines. (Fig. 7.) Lettering can also be treated in this manner, providing a hair-line, outline or compound-line style is used. Otherwise, as noted above, the paint is likely to wipe out after it has been applied. (Fig. 8.)

Lately there seems to be a fad for "antiquing." Paint is rubbed over a relief design and the excess wiped away, leaving only the color that clings around the low spots where the cloth or buffer will not reach. Ivory is most frequently treated in this way, rubbed with umber. At best it is only a spurious imitation of genuine ivory, and fools no one. There are many other ways of decorating or embellishing plastic surfaces: decalcomanias, metal inlays molded into the surface, paint applied through stencils, even branding with a hot iron. Each has its special uses, and the designer should be familiar with the virtues and limitations of all. They cannot be discussed in detail here.

More intricate moldings

Up to this point we have dealt with the simplest of molding operations and equipment—a two-way press, producing, let us say, premium boxes, or compacts, or salt shakers, in single or multiple-cavity molds, designed for rapid production. But there are more intricate styles of molding, producing much more complicated pieces and sometimes employed where cost is

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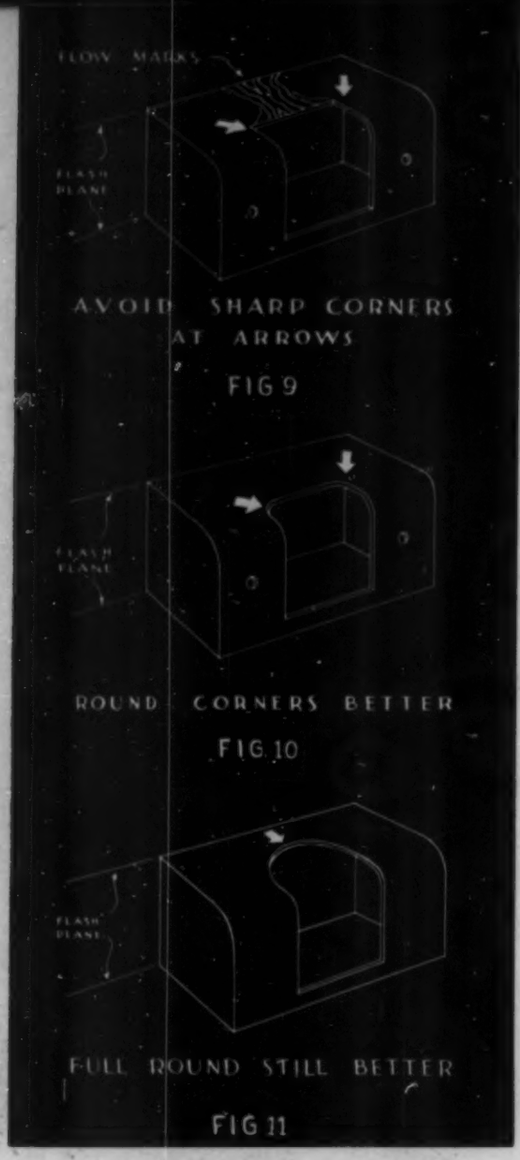

not such a factor. We have said that undercuts are to be avoided, yet they are perfectly possible with a loose piece in the mold, which must be withdrawn before the molding can be ejected. And there are three-way—even four-way—molds, operated automatically by cams, which make extremely complicated shapes a possibility, limited only by the ingenuity of the engineer.

With some of these more difficult shapes, however (which the designer should not attempt until he is thoroughly familiar with molding methods), there are still limitations, due to the nature of the plastics themselves. These must be watched carefully by the designer if the finished article is to be a success.

I refer especially to the shape of openings, and the position and thickness of inside ribs, whether they are there for reinforcement or merely to provide thicker sections for metal inserts or other fastenings.

Let us say we are designing a radio cabinet of the small portable type. It is roughly rectangular, but we wish to have the grille opening on the front face continue up over the top for a certain distance. The cavity of the mold is charged with the molding material, the valve is opened, and the force descends to exert its pressure and heat and make the material flow. The material must make its exit at the flash line, but in order to form the grille opening the final molding must have a thin "fin" over it, only a few thousandths thick, which is later broken out and discarded. Therefore, the plastic material seeking its exit, must flow up the side (the top in the finished radio) and around the opening, joining together again over the opening. If the corners of this opening are sharp and square, it obstructs the free flow of the plastic, makes it difficult for it to join together again, and causes noticeable "flow marks" which spoil the finished piece. (Fig. 9.) A better design would have rounded corners. (Fig. 10.) Or better still, the whole opening could be round at the top. (Fig. 11.)

Structural weakness is likely to be inherent around sharp corners of openings, and in time small fissures may develop which will ruin the piece. Unfortunately, these may not appear for weeks or months. Therefore it is doubly important to guard against the possibility of their developing. Clever mold designers have learned the trick, in cases like this, of avoiding some of the hazards of uneven flow, by making the "fin" quite thick, maybe one-thirty-second of an inch, except at the edges where it joins the body of the piece. This permits a freer flow of material across the opening until the mold has reached its final point of closing. Slightly more material will be used, but it is worth it. (Fig. 12.)

Again, suppose the radio calls for a back closed in by an additional piece, perforated for ventilation, either in a plastic or metal. To provide fastenings, we may design the piece so that ribs run the entire depth of the cabinet (to avoid undercuts) and use tapped metal inserts for screws. If these ribs are located in the center of the sides or top and bottom, the sudden

thickening in this section is likely to show up on the finished piece as darker lines, or in the case of extremely translucent materials, as opacities. In the case cited it would be best to place these ribs at the four corners, where the inequalities of color or surface will show the least. (Fig. 13.)

Non-geometrical designs in bas-relief or intaglio can be produced by other means than hand engraving. Pantographic machines are capable of roughing out all kinds of free-hand designs, using a white-metal master as a guide for the cutting tool. For this the designer should supply either a negative or positive of the design cast in hard plaster from a clay or wax original. Rapid strides are being made toward the perfection of cast molds, such as those made of beryllium copper, which should eventually give the artist all the latitude he needs for the most intricate free-hand forms.

Procedure in design

Now. What shall we say of the procedure in producing a plastic design? Temperaments and tastes differ and no positive outline can be given which will suit all individual cases. We might, however, trace briefly a sensible method of approaching the matter, from the moment the artist conceives the idea, to the finished, marketable molding. With his data thoroughly in mind—general dimensions, final uses, markets, etc.—the designer usually begins to develop numerous ideas in the form of rough sketches. When he has chosen the best of these, one or more are rendered in plan and elevation, or in full perspective. Various media give good results, air brush, tempera, crayon, chalk or watercolor. Prior to this stage he may have done some rough modeling in clay the better to visualize certain effects. When the finished sketch has been approved, he may translate this direct into mechanical drawings, or if the piece is a large one, involving a big mold outlay, he should build a careful model in wood or plaster, finished in lacquer to simulate the plastic material.

Sometimes he may be called upon early in the game to provide prints for estimate. These need not be fully dimensioned, but should show outlines, giving the principal dimensions and the required thickness of section so that the amount of material in each molding may be computed. When final approval is obtained, and the molds ordered, he must present fully dimensioned drawings as the finished piece should finally appear. From these the toolmaker prepares his mold drawings. If free-hand forms are involved, the designer should provide hard plaster casts of the difficult parts.

Nothing must be left to the imagination of the toolmaker. Rough sketches are not enough. I have known cases where the molder attempted to build his molds from the perspective sketch of the artist, with sorry results. Even a careful airbrush rendering in plan and elevation is not a sufficient guide—unless the designer does not care about seeing his work come out as he conceived it. It is patently impossible to tell any one how to produce artistic design. But if I have succeeded in pointing out some of the possibilities and the limitations of molded plastic work in this brief paper, it will not be an entirely wasted effort.

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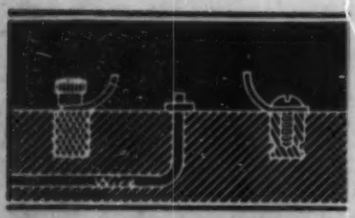
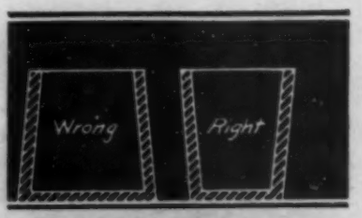
ADVANTAGES AND LIMITATIONS of Phenolic Molding Compounds

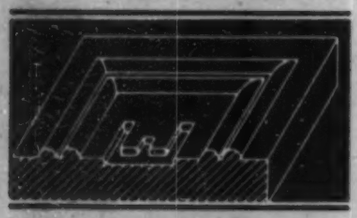
Modern Plastics here presents, through the courtesy of General Plastics, Inc., a graphic tabulation of Phenol-plastic properties which you will want to keep on your files. *Don't tear this page out.* Write for a reprint, on heavy stock, suitable for filing.



INSERTS—threaded metal inserts, contacts, terminals, wires and inlays may be imbedded in phenol resins during the molding process, making later assemblies easier, less expensive, stronger.

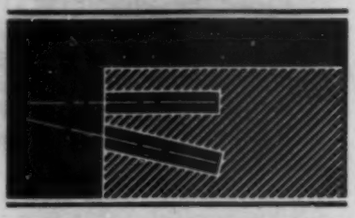
UNDERCUTS—phenol molding compounds set hard in the mold. Cavities and holes therefore should be straight, without undercuts or projections to prevent straight ejection from the mold. Undercuts can be handled in split molds, but cost more.





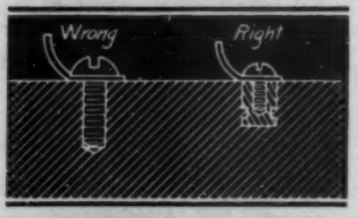
DETAILS—lettering, trademarks, decorative details, ribs, can be molded into any phenolic resin piece, provided they permit withdrawal from the steel mold. Simple ones add little to the cost, especially if they can be machine cut or hobbed in the mold.

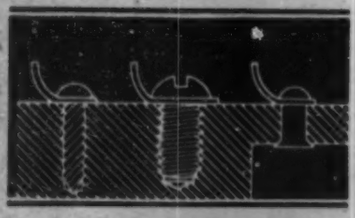
SIDE HOLES—though practical, horizontal side holes in a molded piece slow the operation, and lead to breakage. Sometimes they're necessary, but avoid them if possible. Slanting or oblique side holes are even more troublesome in molding.



SINGLE OPERATION—most molded phenolic resin pieces come from the mold virtually ready for packing, with removal of slight "fins" the only finishing needed. Thus formerly complicated assembly jobs become single operations with no buffing, plating or coating necessary.

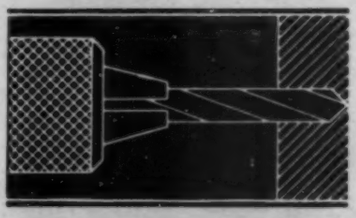
TAPPED HOLES, NAILS—small tapped holes in molded phenol resins are laborious and not very practical, except where strain is light. Threaded metal inserts are stronger, more permanent. Driving nails in phenol molding compounds is impossible.

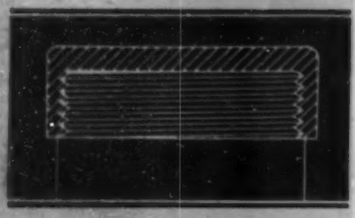




TAPPING, RIVETING—molded phenol molding compounds can be drilled and tapped without difficulty, or, if the strain is light, holes can be molded in, and drive screws used. Rivets often facilitate assembly, but should be carefully specified.

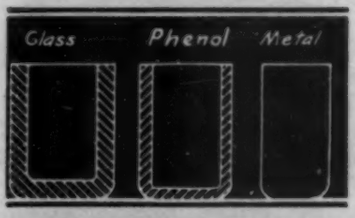
MACHINING — machining molded phenolic resin pieces is practical but difficult. It dulls tools rather quickly, requiring alloy steel or diamond cutters for high production work. Sometimes a machining operation is economical because it eliminates a split or complicated mold.





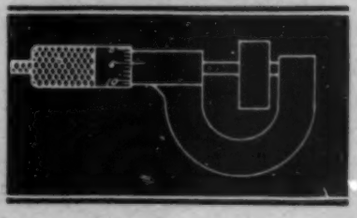
THREADS—strong accurate threads can be molded into phenolic resins without extra operations, permitting permanent joining of sections, or easy removal without binding or stripping.

WALL THICKNESS—wall thicknesses should reflect a material's tensile strength. Thus phenol molding compounds require thinner cross-sections than glass but thicker than metal.



INTEGRAL COLORS, FINISH—the colors of molded phenolic resins extend all through the piece, and are not applied. They can't chip, peel or wear off. The lustrous surface is also integral with the piece, and never corrodes, dulls, clouds, checks or loses its original sheen.

TOLERANCES—tolerances can be held to plus or minus 0.002" on smaller dimensions, or plus or minus 0.004" on larger. Unless necessary, avoid specifying closer limits. Ordinarily, plus or minus 0.004" is the accepted tolerance for precision molding.

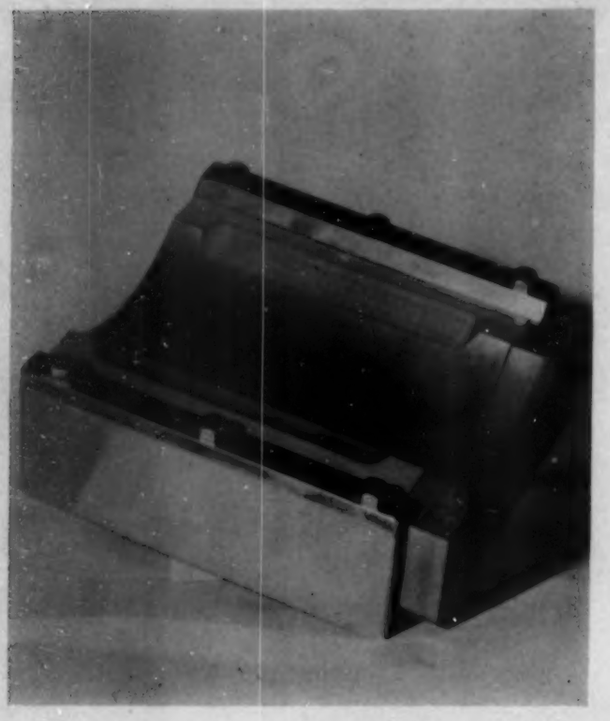


INDUSTRIAL and DECORATIVE LAMINATING

Pages 227 to 244

Laminated plastics in industry

BY R. D. WALLIS*



Micarta roll neck bearing

Textolite rayon spinning bucket

ONE August afternoon in 1909, a group of engineers and workmen were watching an antiquated hot plate press in the Westinghouse Plant with breathless interest. The steam sizzling out of the joints around the platens did not help the temperature any—but the men themselves were oblivious to the added discomfort. They were watching the pressing of the first sheet of Laminated Phenolic Plate. Some days before that they had received the first "huge commercial shipment of eight barrels of Bakelite Varnish from General Bakelite Company's Perth Amboy, New Jersey, plant." [1]

Heretofore, engineers had proven conclusively that resinoid varnish could be used in making tubes superior to anything in the electrical industry for insulation—but so far the art of making a flat plate so that it would not stick abominably to the pressing plates had eluded the engineers. At last the time was up, and a perspiring workman went around the press, turning off the valves here and there. Presently the sizzling mass began to cool down, and after it was calm and quiet the pressure was cut off and the crucial moment had come.

Of course the world knows the outcome. The first press load of laminated plate built up of layers of paper which had been impregnated in the phenol-formaldehyde varnish was a success. Here was a material which began to unfold surprising possibilities in the chemical and mechanical field. Lighter than aluminum, as strong as steel pound for pound, harder than ebony, flexible as cold rolled steel—the field of mechanics began to see the remarkable possibilities of the material. Electrical engineers took a keen interest in the new laminated plate because of its high resistance to moisture, uniform wear, resistance to temperature up to 250 deg. F, its ease of fabrication—and of course principally because of its remarkable insulation qualities. By actual test, 62,000 volts of electricity were required to puncture a plate of the new material $\frac{1}{16}$ in. thick.

Soon it was discovered that additional shapes, such as U shaped channels, angles, and solid rods could be made from the new material. The next development was the manufacture of laminated plastic plate using various types of cloth or fabric as the laminating agents.

These types of materials were found to have greater mechanical strength than plate built up from paper base. It was found that again the possibilities for applications in mechanical fields for various types of pinions, gears, and wearing rings and plates had been multiplied. Then very soon came the dark days of the World War, and the effect of the hectic abnormal manufacturing conditions of those days was very ap-

* Manager Micarta Sales, Westinghouse Electric and Manufacturing Company.
[1] Bakelite Review—Silver Anniversary—Vol. 7, No. 3, Page 6.

Soda bar of Formica installed by the Bastian Blessing Co., Chicago. Bar top is red with silver inlay

parent on the new and rapidly growing infant industry. At the beginning of the war there were large quantities of phenol on hand in America. However, as a result of war conditions the price of phenol advanced from six cents to two dollars per pound.

In the meantime, through war impetus, another industry was beginning its spectacular career—that of aviation. In the manufacture of airplanes, the new material took its place in many ways. The uses included moving parts from the humble little pulley over which the aileron leads ran, to ten foot molded propellers.

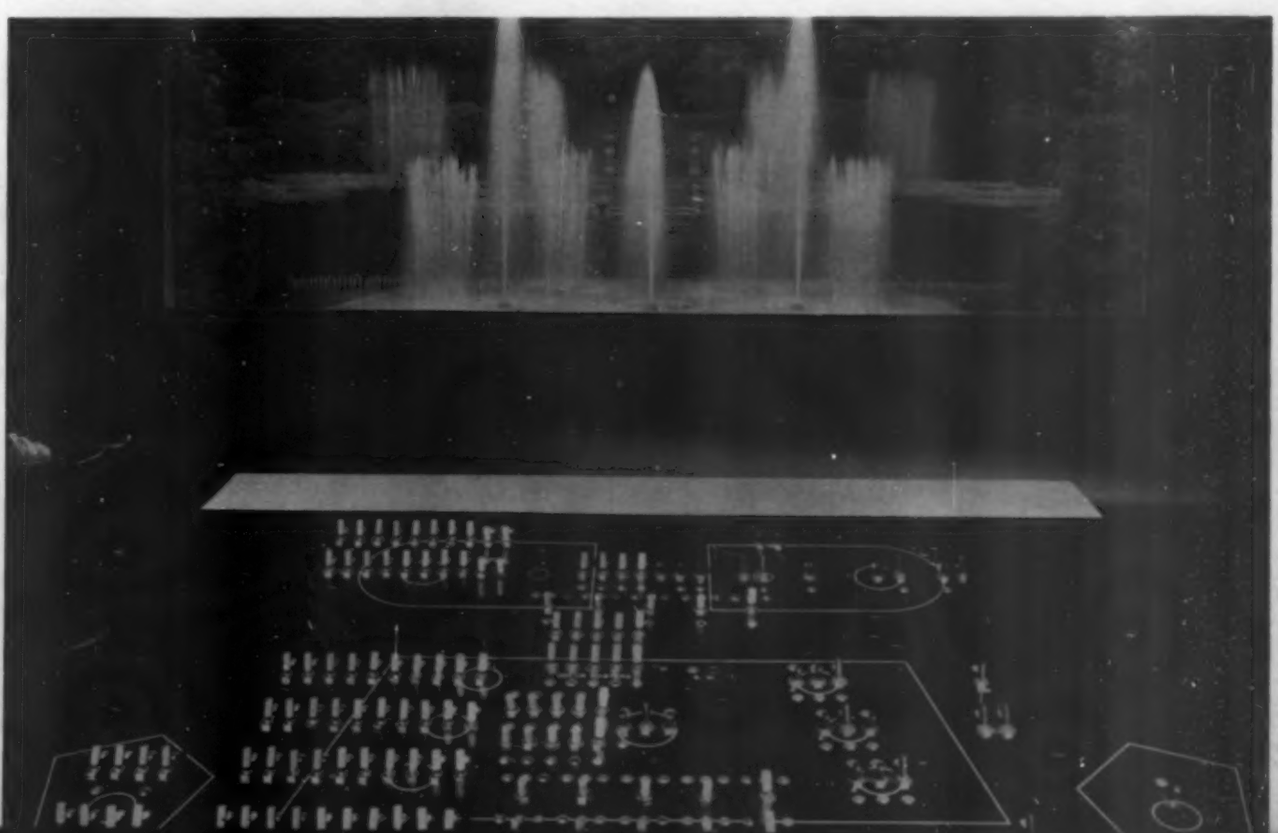
In the meantime, another remarkable industry was going through its first struggling days—radio. It was in the field of radio that laminated plastics made their first real growth. The new industry mushroomed up over night, and laminated plastics received a tremendous impetus because of the fact that in its various forms engineers found a material almost perfectly adapted to the manufacture of various punched pieces, panels, plates, washers, coil forms, etc.

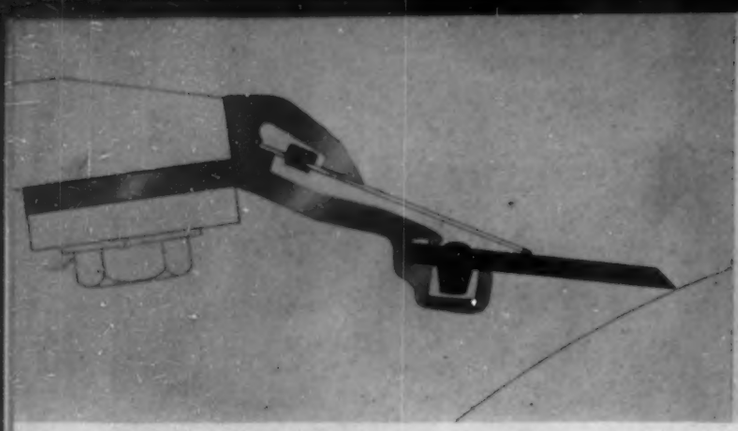
These parts entered the marketing field, not only in mass production in the manufacture of radio sets, but also through a completely nationalized marketing set-up, the purpose of which was to place all such available parts in the hands of amateurs all over the country, whose chief joy it was to tinker with radio at the cost of their own sleep at night and the affections of their families.

Then after reaching a peak in the electrical field due to the radio industry, the decline of the latter industry and the beginning of the depression caused the laminated plastics industry to go through its first real test. It was necessary on the part of all manufacturers to expend their best engineering efforts in the development of new and varied applications, both mechanically and electrically. In accomplishing this end, intensive studies were made of such industries as follows:

The Automotive Industry..
The Petroleum Industry and its allied products.
The Chemical Industry.

Phenolite control board for handling the water and illumination of the fountains at the Open Air Theater on the estate of Pierre S. du Pont. (Photo, courtesy National Vulcanized Fibre Co.)





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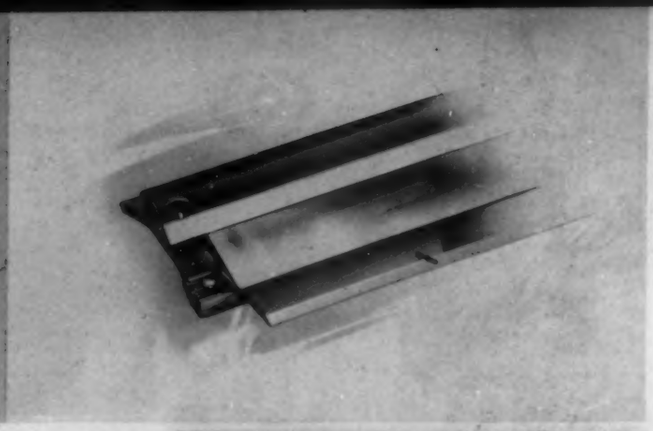

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1-2. Formica doctor blade used in paper making machinery. The blade is a beveled edge strip of Formica which scrapes excess pulp from the roll keeping it clean. Mounting is illustrated in Fig. 1. 3. Synthane Risonite Explosives Container used for holding nitro-glycerine employed in shooting oil wells. 4. Formica wall board and Verde Antique shelves in women's dressing room, "SS. Dixie". 5. Textolite loom picker made by General Electric

The Machinery Manufacturing Industry.
The Steel and Metal Working Industry.
The Textile and Synthetic Cloth Industry.

As the result of these studies, needs were found in practically all of them for laminated plastics, in which certain characteristics would be particularly stressed. This led to the development by various manufacturers of various grades of material, each with its special set of characteristics.

About this time the Laminated Plastics Group of the National Electrical Manufacturers Association was established, and functioned to assist the various manufacturers in establishing standardized grades, both in paper base and fabric base materials. The Laminated Plastics group of N.E.M.A. is composed of the following manufacturers, all of whom subscribe to the standards and practices of the N.E.M.A. group:

Continental-Diamond Fibre Company
Formica Insulation Company
General Electric Company
Mica Insulator Company
National Vulcanized Fibre Company
Panelyte Corporation
Spaulding Fibre Company
Synthane Corporation
Taylor and Company
Westinghouse Electric & Manufacturing Company

The various grades of laminated plastics as established by the N.E.M.A. group as well as the characteristics which establish the grades, the tolerances which are accepted the world over as standard, and the various methods of making the tests, are described in the publication of the National Electrical Manufacturers Association, Laminated Plastic Products Group, Publication No. 34-26, dated June 1934.

Briefly, these grades include four standard specifications of paper base, laminated plate, known as grades X, P, XX and XXX. Also, four grades of fabric base laminated plate specifically known as grades C, CE, L, and LE. The adoption of these standards on the part of manufacturers has proved a real step forward in the industry. Such standards have enabled pur-

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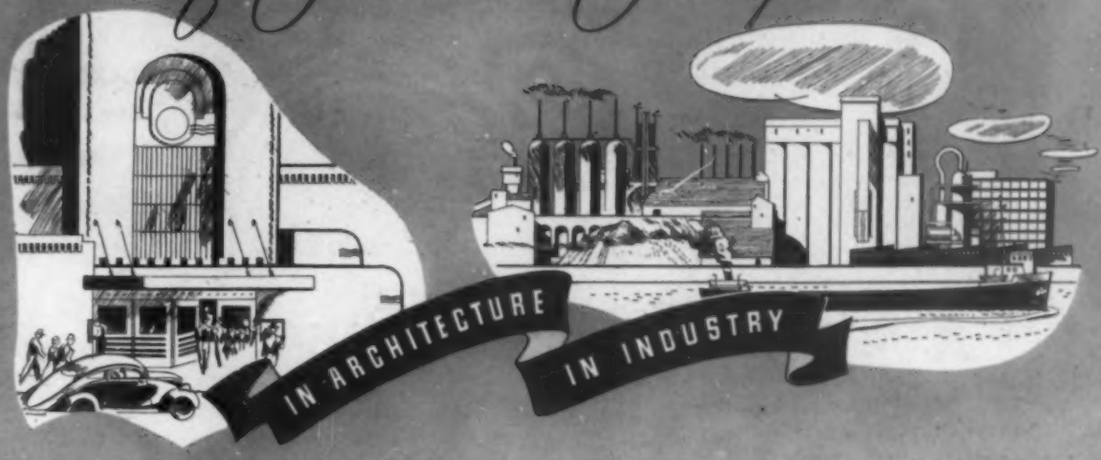

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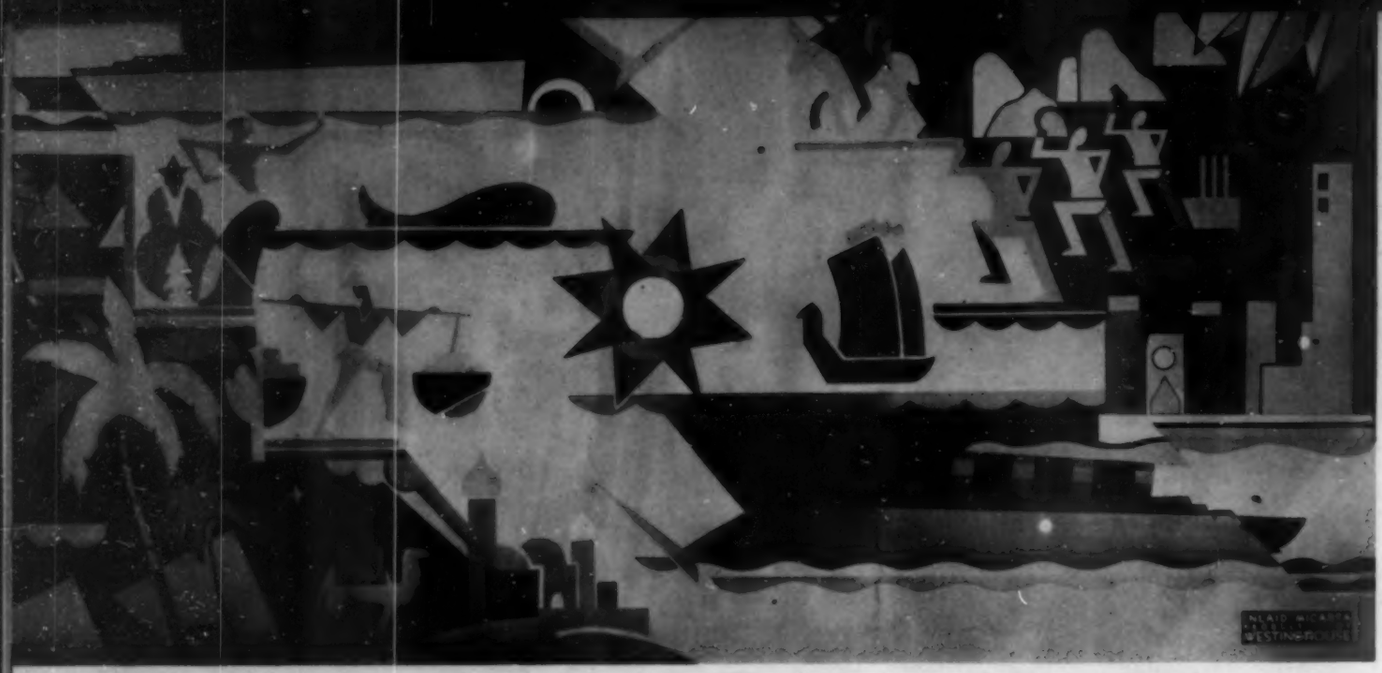
Westinghouse ARCHITECTURAL INDUSTRIAL MICARTA WESTINGHOUSE 1886 1936 GOLDEN JUBILEE



A demonstration panel of inlaid Micarta, product of Westinghouse Electric & Mfg. Co.

chasers, first, to determine the particular grade which will do the work required to the best advantage, and, second, to make sure that their specifications are understood by all manufacturers, and that materials furnished are as specified.

In the paper industry, one of the outstanding uses of laminated plastics has been the perforated suction box cover over which the Fourdrinier wire screen passes. Results obtained in the production of superior grades of paper as well as economies due to the saving of wear on the wire, have been of great value. Laminated plastics are also used in various grades for such important parts of the paper making machine as doctor blades, shake springs, toe blocks, gears, valve discs, table rolls, and rings. These are but a few of the uses in the paper industry.

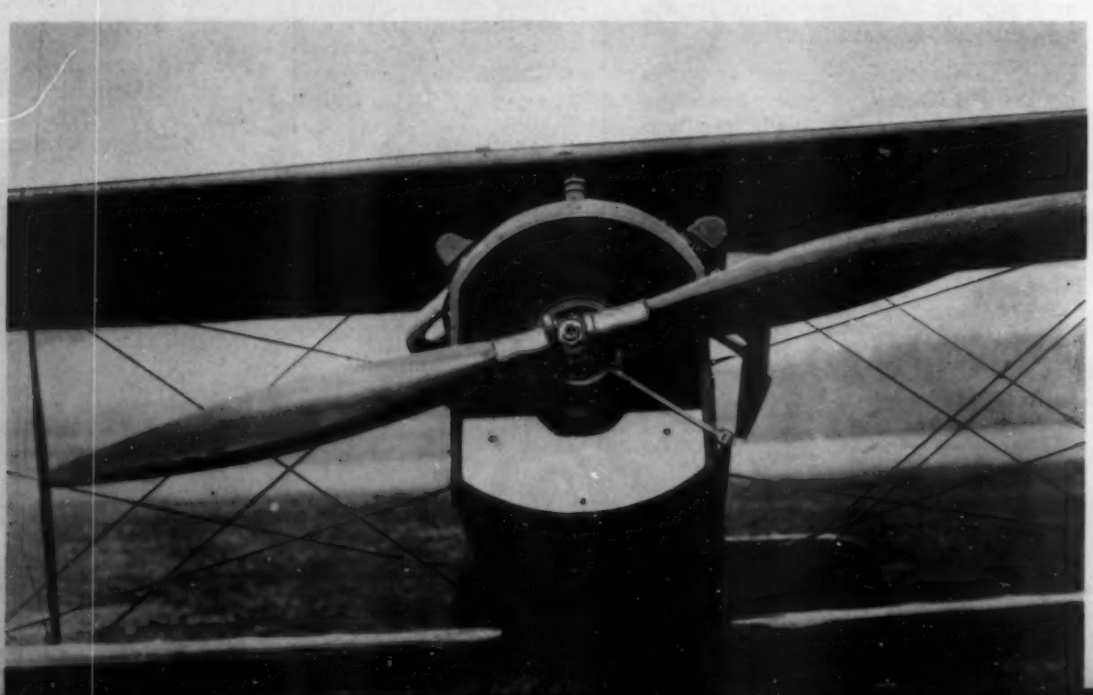
In the textile industry, particularly in the manufacture of rayon, the laminated spinning bucket has aided production. These buckets have been produced to withstand the terrific strain of 10,000 revolutions per minute. Other examples of typical uses in the textile industry are in the manufacture of bobbin shells, spools, and spool ends, picker sticks, etc.

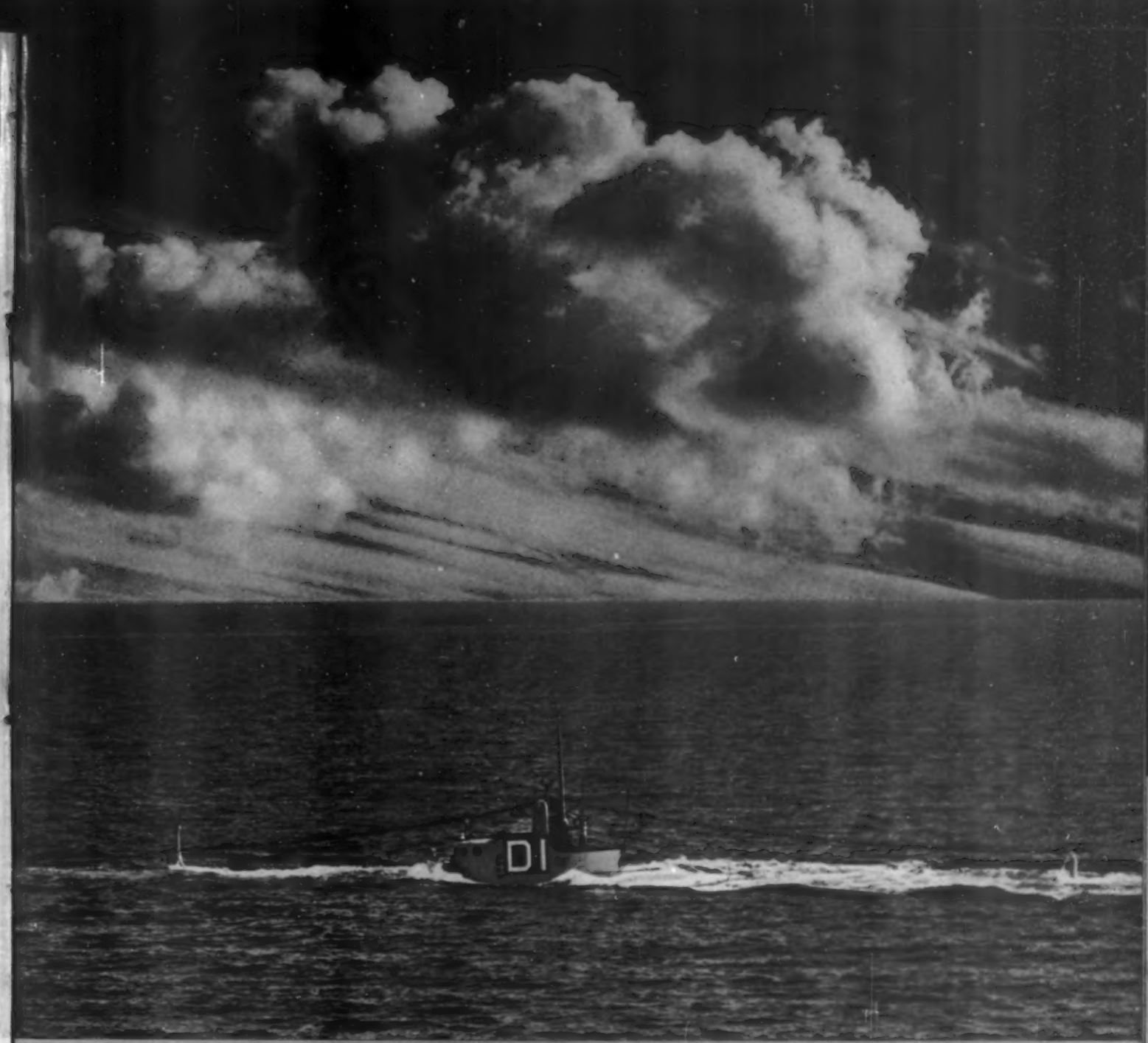
In all of the mechanical industries, particularly the automotive industry, the development of the fabric base laminated plastic material for gears and pinions of all types has meant a progressive step. In factories, the reduction of noise and therefore of nervous tension and fatigue resulting from constant clatter of metal gear trains, has proved a real blessing to operators. Such commonly accepted results as long life, ease of replacement, and ease of lubrication, have come to be accepted characteristics of the composition laminated plastic gear.

In the steel and metal working industry, one of the greatest boons to modern production has been the introduction of the laminated plastic roll neck bearing. This type of bearing is manufactured and distributed by a number of the laminated plastic manufacturers, and is proving to be a real economy in production and maintenance cost.

In the petroleum industry, composition valves and

Micarta propeller developed during the World War, and used with Liberty motor





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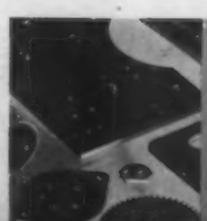

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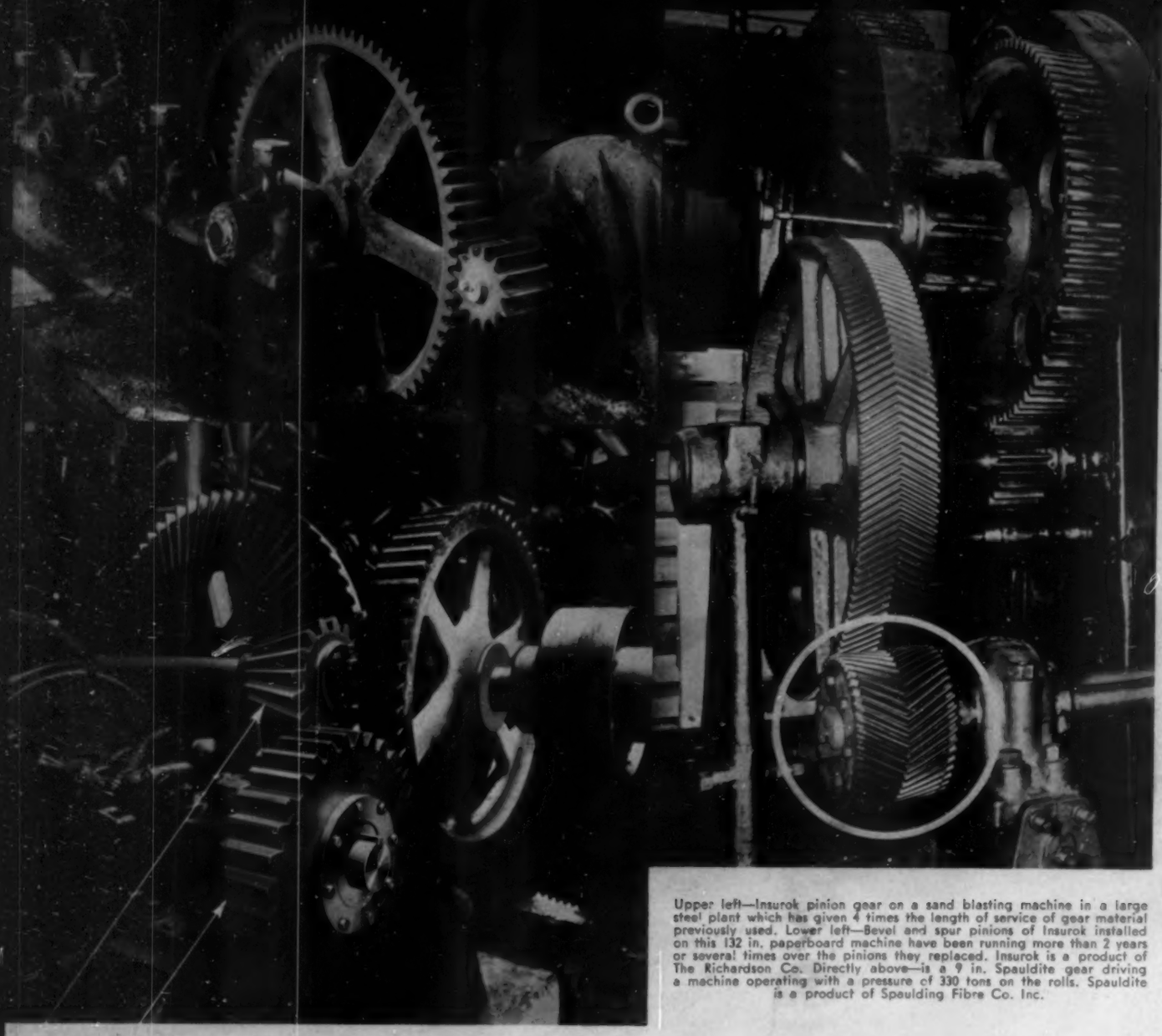


Upper left—Insurok pinion gear on a sand blasting machine in a large steel plant which has given 4 times the length of service of gear material previously used. Lower left—Bevel and spur pinions of Insurok installed on this 132 in. paperboard machine have been running more than 2 years or several times over the pinions they replaced. Insurok is a product of The Richardson Co. Directly above—is a 9 in. Spauldite gear driving a machine operating with a pressure of 330 tons on the rolls. Spauldite is a product of Spaulding Fibre Co. Inc.

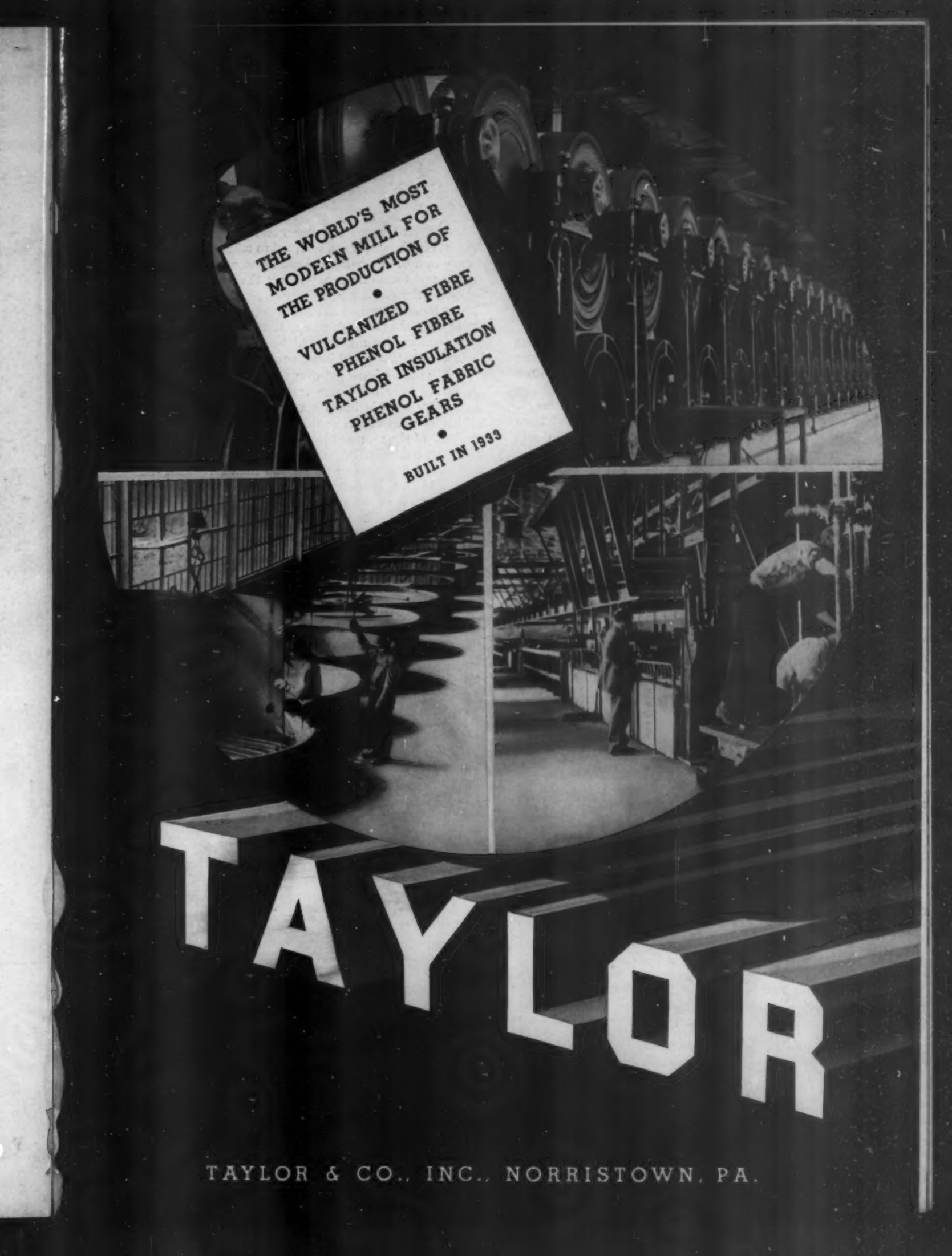
rings have become almost universally accepted because of their resistance to the acids encountered in handling various types of oil products. These represent but a few of the thousands of applications in which laminated plastic materials are doing an outstanding job in the electrical and mechanical fields.

The latest chapter in the romantic history of this material is written in the architectural field. In the late 20's, the art of introducing colors, designs, and patterns into paper and fabric, impregnating these with different types of varnishes, and molding them into solid sheets, was discovered. These materials are particularly adapted to the fabrication of various types of furniture and store and office fixtures, as wearing tops on tables, desks, counters, and bars, and as wall treatments, both in commercial and residential buildings, and in ships at sea.[2]

Architects, builders and manufacturers throughout the country have recognized in decorative laminated, a new material with a great variety of decorative possibilities as well as utility. Laminated plastics are in no sense an imitation of natural materials, but represent a new tool in the field of decoration. The use of decorative laminated plastic is therefore growing very rapidly with the return of better building construction and reconstruction on land and sea.

In attempting to summarize the history and development of the laminated plastics industry, we are impressed chiefly by the fact that after all, the discoveries and ingenuities of mankind live and grow in terms of the service they render to man. Laminated plastics, from the time of the first crude plate made with that obsolete machinery in the Westinghouse Plant in 1909 to the present date in which millions of pounds are manufactured and used annually, is a continued story of rather remarkable service in the fields of chemistry, electricity, and mechanics. All of us in the industry have a humble feeling that we have scarcely scratched the actual possibilities of the material. Future chapters in the story of laminated plastics will very likely tell of even more far reaching importance and development.

[2] The story of decorative laminated plastics appears on page 236.


THE WORLD'S MOST
MODERN MILL FOR
THE PRODUCTION OF
•
VULCANIZED FIBRE
PHENOL FIBRE
TAYLOR INSULATION
PHENOL FABRIC
GEARS
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BUILT IN 1933
TAYLOR
TAYLOR & CO., INC., NORRISTOWN, PA.

Laminated plastics for decorative uses

BY W. G. STEINER *

IT IS now nine years since laminated plastics were first offered for decorative uses in connection with furniture, fixtures and building. Before that, in the days when practically all radio sets had a complete front panel of laminated insulating material, various wood grains had been developed to harmonize with radio cabinets, but this wood finish material had not been used for other than radio purposes.

These wood finishes for radio, however, were the forerunners of the present development of decorative laminated. For the radio manufacturers began to use wood fronts on their cabinets, depending on bushings and small interior parts for insulation. That meant a big decline in volume for laminators, who had been selling $10 worth of material for a single radio, and they had to look around for new outlets.

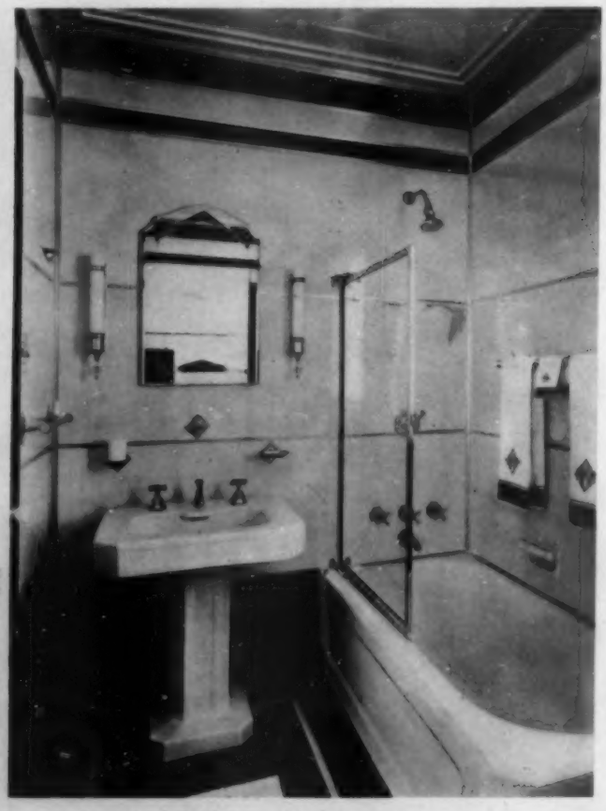
It occurred to some one that if wood finishes could be made in laminated, so probably could marble finishes which could be used for table tops. It would have much better chemical qualities than marble, be lighter and non-breakable. So shortly the first marble imitations were made with laminated plastics.

* The Formica Insulation Company

An effort began then to sell the material in the form of veneers to furniture and fixture manufacturers, but they were not inclined to take on the rather heavy task of educating the public to a new material, and it was found necessary to put the veneers on plywood at the plant and ship the complete table tops. These were advertised to certain groups who had been using higher grade table tops at a comparable price, and soon a nice market had been developed in the field of restaurant and hotel equipment.

It was soon discovered that designers and architects as a rule were not much interested in imitations of wood and marble but wanted plain flat colors with which modern effects could be obtained. Up to that time all of the material had been made with phenolic resins exclusively, but when the demand came for colors, it was necessary to develop urea formaldehyde sheets, or combination sheets, part phenolic and part urea, because of the greater stability of color possible with the ureas. The next step was the development of methods of producing designs by inlaying metal in the sheet when it was made, or of inlaying one color over another, and finally of inlaying photographs. These

Blisterproof Formica table tops and shelving with white metal inlay in club car, Illinois Central Railroad



Light colored Micarta paneled bathroom in the home of Mrs. A. W. Robertson, Ventnor, N. J.

Counter paneling and tops Formica, store of Snelgrove Ice Cream Company, Salt Lake City. Built and installed by the Salt Lake Cabinet & Fixture Company . . . Cannon & Fetzer, Architects.

Complete Store Equipment SURFACED WITH FORMICA

THE striking modern store of the Snelgrove Ice Cream Company, in Salt Lake City, is an example of the colorful, modern effects that are made possible by the use of Formica paneling and tops. Surfaces of all the fixtures in the store have been covered with Formica because of its smoothness and cleanliness, its color and the attractive designs that can be worked into it by the inlaying process.

Formica is a thoroughly modern material, without an equal for such purposes. It adds a selling punch to the store equipment that has been known to double sales at the same location and in the same space.

Let us tell you all the facts.

THE FORMICA INSULATION CO.
4671 Spring Grove Ave., Cincinnati, O.

FORMICA

FOR FURNITURE & FIXTURES

Inlaid Micarta showcase and shelves in the Aurach and Perl store, Baltimore, Md.

Formica bar top and table top in the cocktail lounge, Hotel Jermyn, Scranton, Pa.

Above—Office in the M. H. Renkin Dairy, Brooklyn, N. Y., with Micarta walls. At right—One of the bathrooms on the SS. Queen Mary finished in Formica

developments opened very wide possibilities to designers and greatly improved the attractiveness of the material for all sorts of purposes.

Laminated plastics are used for decorative purposes essentially as an exterior finish. They provide a surface with qualities that were never available in combination in any one material before. The surface is perfectly smooth, in keeping with the modern trend, and is available either in an exceptionally high gloss or in a satin finish, secured by rubbing with pumice. The material is hard and durable, harder than marble, but not quite as hard as glass. This hardness is not accompanied by brittleness. The material is not easily broken nor will it chip.

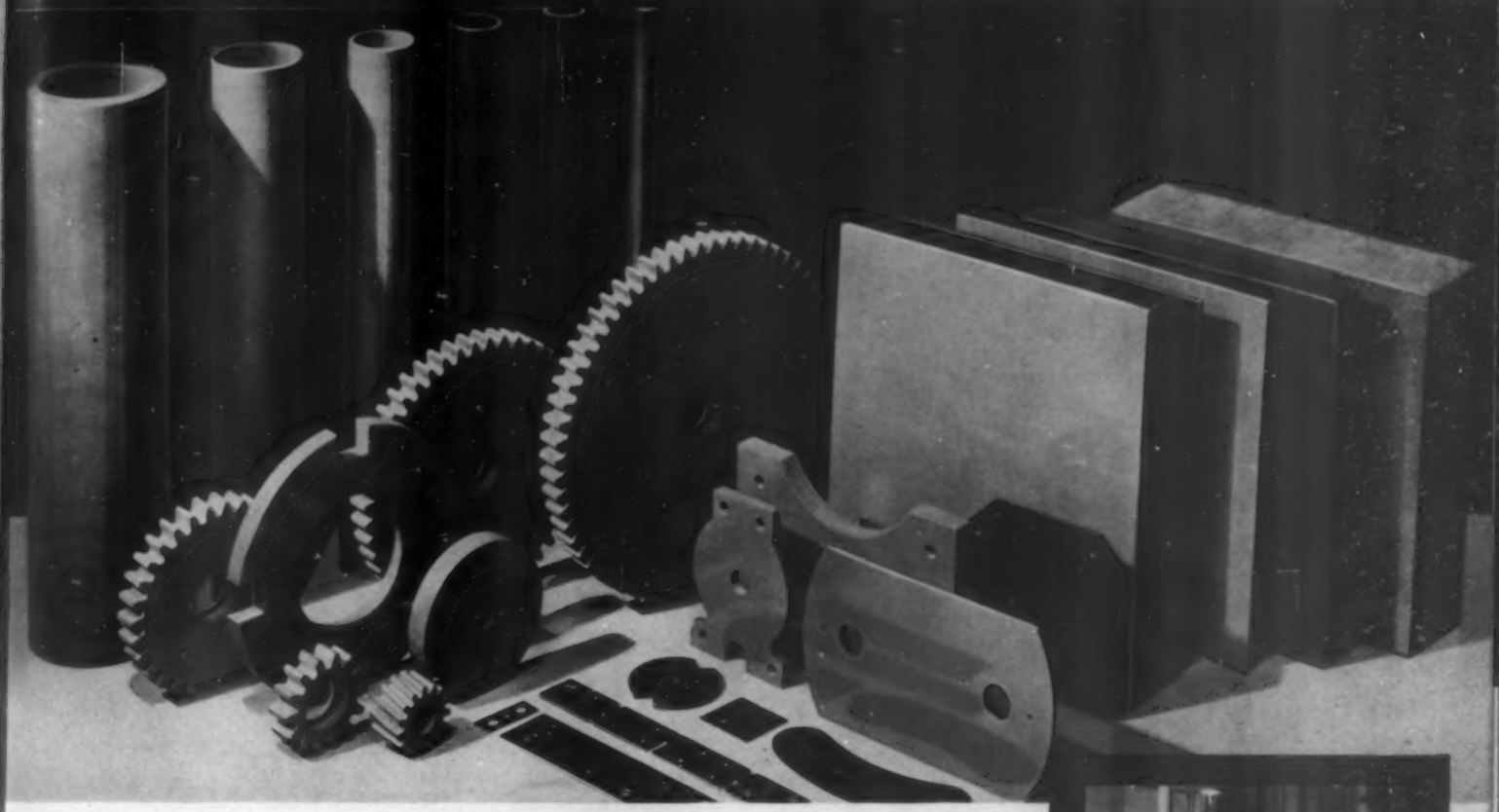
Equally important is chemical inertness. The phenolic types offer probably the most inert and non-reactive material of an organic character that is available. This, of course, provides freedom from staining with liquids of various kinds and gives the surface an extreme degree of permanence. They can be washed with solvents such as alcohol, benzol, acetone, or paint remover, which are fatal to materials previously used.

The material was always quite resistant to heat, the phenolic sheet standing above 300 degrees Fahrenheit without injury. Recently, means have been developed of rapidly spreading the heat from a cigarette or lighted cigar, so that dangerous temperatures cannot be reached from the heat of a lighted cigarette, and that made it possible to offer grades that can be guaranteed to be "blisterproof" so far as cigarette burns are concerned.

The material is currently offered for decorative purposes in a number of forms for different purposes. For furniture and fixture manufacturers it is provided in a veneer sheet $\frac{1}{16}$" thick which may be sanded on the back to provide a rough surface, to which glue can take hold, and applied to the tops of furniture and fixtures. The $\frac{1}{16}$" thickness was set by several factors. It proved to be the thinnest sheet that would prevent grain markings and slight imperfections in the plywood from showing through the finished top. It was also the thinnest sheet it was practical to manufacture in colors due to the fact that on thinner sheets it was increasingly difficult to hold the color uniform over the whole area of the sheet, with the result that rejec-

Bakelite Laminated...

A MATERIAL OF LIMITLESS SERVICE



Sheets, tubes, punchings and gears of Bakelite Laminated (Lamicoid) produced by Mica Insulator Co.

IT would be difficult to name another material now performing such widely varied functions as Bakelite Laminated. Present advantageous applications of this material range from structural decoration to the strengthening and silencing of gear drives; from providing fire resistant trim and furnishings for passenger ships to insulation of high frequency electrical equipment; and from the forming of strong, light-weight appliance parts to the making of non-corrodible pipe.

Notwithstanding these and hundreds of established uses for Bakelite Laminated, the possibilities of further advantageous applications are practically unlimited. Combined in this one material are characteristics of major value to nearly every industry and science: mechanical strength, light weight, resilience, durable lustre, fatigue life, electrical insulation value, dielectric strength, permanence of form, and resistance to abrasion, moisture, chemicals and solvents.

Bakelite Laminated is available in standard shapes—sheets, rods, tubes and gear blanks of many dimensions. It can readily be obtained in special shapes and sizes. For decorative purposes a variety of attractive colors are available. It may be sawed, drilled, punched or otherwise machined with ordinary tools. Our engineers will be glad to cooperate with you in applying this versatile material to greatest advantage in any proposed design.

See pages 47 and 309 for useful information on other Bakelite Materials.

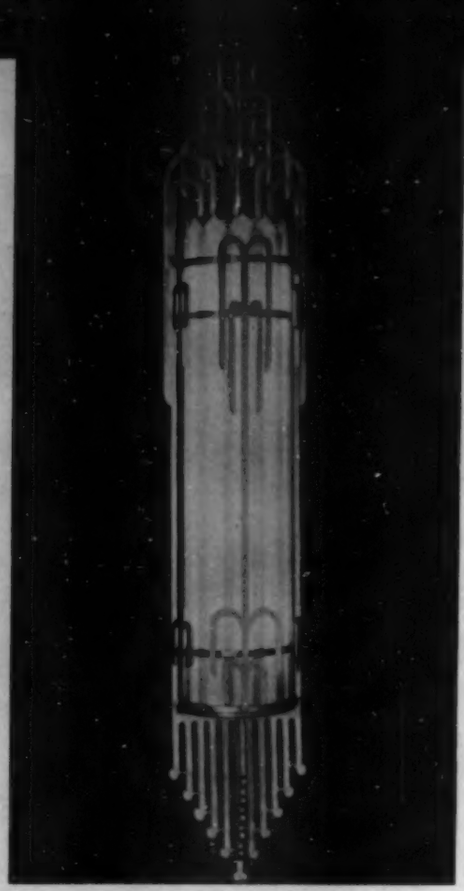
BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N. Y.
BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin Street, Toronto, Ont.

BAKELITE

The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the symbol "B" is the numeral sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

THE MATERIAL OF A THOUSAND USES

Soda fountain at Steinbach-Kresge, Asbury Park, N. J., with back bar, wainscoting and table tops of Formica



Theater wall bracket designed by the King Scenic Co., Dallas, Tex. The diffusing drum is made of translucent Formica

Above—Beauty shop, Mably & Carew, Cincinnati, Ohio, with laminated table tops that are easily kept clean. Below—Physician's office in the Cinco Building, Grand Junction, Col., with doors, desk, and inlaid wainscot. Formica is used in both installations

tions in manufacture often became unreasonably high.

Table and counter tops veneered in the plant of the manufacturer of the laminated material are offered by some producers, while others sell only the veneer itself. These table tops are made by covering five-ply wood on the top, edges and frequently on the bottom with the plastic veneer. The sheet is added to the bottom so that more moisture would not penetrate the bottom than would penetrate the sides and top when the humidity changes, as that would cause warping.

Another form of the material is a wall board in various thicknesses—$\frac{5}{32}$", $\frac{9}{32}$" and $\frac{11}{32}$"—developed for wainscoting. This consists of a sheet of chest-tempered pressed wood made of compressed wood fibres, as a center, with a laminated plastic surface fused on both back and front, although color may be used on the front only. In short, the pressed board is used as the center of laminated plastic sheet with laminations on front and back. It is necessary to treat the back the same as the front so that the sheet will remain flat and will be water-proofed.

At one time asbestos board was used in this same way as the center of plastic sheet, but the pressed board has proved almost equally unaffected by moisture and has been satisfactory for store fronts. As it can be made in a greater color range, and with inlays, and it is much easier to cut so that it can be handled by carpenters on the job, it has practically displaced the asbestos center sheets because of this convenience.

Recently some attempt has been made to use steel

These 3 New

LAMICOID MATERIALS

offer many interesting possibilities in product design and improvement!

LAMICOID

Lamp Shade of Translucent Lamicoid

TRANSLUCENT LAMICOID

The attractive lamp shade shown is made of this interesting new material . . . a flexible, laminated, translucent sheet of uniform structure and color.

Admirably suited for applications requiring rear illumination . . . convention exhibits, counter and window displays, signs, radio and instrument dials, etc. Replaces celluloid and glass in many instances.

Low in cost . . . non-inflammable . . . non-shatterable . . . light in weight . . . unaffected by moisture . . . readily cleanable. Easily printed and sand-blasted.

Colors: White, amber, green, red and blue. Others to order. *Finishes:* glossy, satin. *Sheets:* 36″x42″ from .010″ to .062″ thick.

ENGRAVING LAMICOID

The eye-catching display sign panel shown, used by a prominent maker of hair-dressing equipment . . . is made of our Translucent Engraving Lamicoid, a laminated synthetic resinoid sheet material.

The surface is lustrous black. The lettering and design are engraved through the black surface, exposing the white translucent material underneath, which is illuminated from the rear.

Also available with black surface but an opaque white core . . . or opaque white surface and opaque black core. Other color combinations to order.

Display Panel of Translucent Engraving Lamicoid

Uses: Window and counter display signs, doctors' nameplates, X-ray and other apparatus panels, road direction signs, etc.

Lettering and designs engraved on Engraving Lamicoid are clean-cut and PERMANENT. Nothing to wear off. Easily drilled and machined . . . strong mechanically . . . good insulating properties . . . non-inflammable . . . unaffected by moisture.

Sheets or fabricated panels. *Standard Sheets:* 36″x42″, thicknesses from 1/32″ up.

GRAPHIC LAMICOID

There has long been a need for a durable, economical sheet material in which lettering, designs, colors, diagrams and other similar matter could be readily and permanently incorporated. Graphic Lamicoid fully meets this need.

This material possesses the general mechanical and electrical qualities of laminated synthetic resinoid products. The printing, design or other matter is incorporated in the sheet and cannot be removed or erased.

Made in two types: opaque and translucent. The translucent type is suitable for applications requiring indirect or rear illumination. Standard Graphic Lamicoid is made in ivory-white color with black printing. Other colors obtainable.

Uses: Charts, wiring diagrams, maps, graphs, nameplates, radio and instrument dials, signs, displays, drafting instruments.

Standard Thickness: 1/32″ and 1/16″. *Finishes:* Glossy, Satin and Graphic—a special finish suitable for writing on with pencil or ink and erasing, repeatedly.

Radio Test Panel made of Graphic Lamicoid

PRICES AND SAMPLES

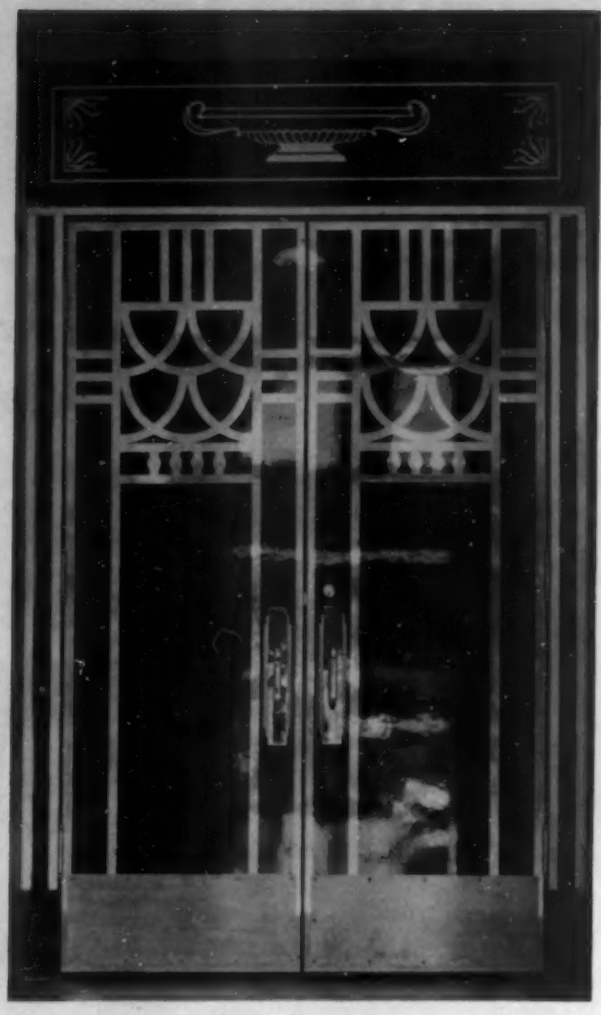
Ask for samples of these new materials. When you see them, we are confident you will appreciate their great possibilities in product design and improvement. Complete information and prices gladly furnished.

Other "Lamicoid" Products:—Lamicoid Laminated Bakelite Sheets, Rods, Tubes. Lamicoid Decorative Plate. Lamicoid Bonded Metal.

MICA INSULATOR COMPANY

200 Varick Street, New York; 542 So. Dearborn St., Chicago; 1276 W. 3rd St., Cleveland. *Branches at* Birmingham, Boston, Cincinnati, Los Angeles, San Francisco, Seattle. *Canada*: Montreal, Toronto.

Bathroom in the home of Lawrence Ottinger, Scarsdale, N. Y., with walls of Micarta



Black and aluminum inlaid doors of Formica in the Paramount Theater, Lake Charles, La.

as the center of a plastic sheet, and this can be successfully done with certain colors. However, these steel sheets cannot be bent or formed without destroying the plastic surface; they are hard to cut and handle, and for these reasons their application has not been very great.

One of the most recent developments in the decorative plastic sheets has been a translucent material. This is a solid urea formaldehyde sheet made with a special fibre base. It provides sufficient translucency for panels on counters, signs, louvres, and lighting fixtures. It is not brittle and possesses more mechanical strength than most materials that will pass an equal amount of light.

Those who appreciate design as a means of making commercial establishments more attractive to customers have taken the lead in the use of laminated plastics, and while a certain amount has been used in private homes and apartments, by far the greater part of its use up to this time has been in stores, theatres, restaurants, hotels, ships, railway cars, and public buildings. Counters of all types are built with it. Soda fountains, bars, perfume counters, lunch counters, and cashiers' desks. And in most cases table tops of the same material go with these counters. Frequently also the room will be paneled in laminated plastic wainscot sheet harmonizing with the other equipment, and doors and a store front may be added. If a really complete plastic job is desired, window stools, radiator covers, and signs can be included.

In homes and apartments the most common uses have been window stools, bath room and kitchen wainscoting, and kitchen cabinet tops. In public buildings it has been used for doors, desk tops in post-office corridors, clerk of court desks, telephone booths, wainscot and many similar uses. The material has been accepted nationally by leading commercial designers and by a very large number of important architects, and as building expands it is being more and more widely used.

Some of the more interesting recent specifications for the material cover a very wide range of activity. The Woolworth and Liggett chain store systems have standardized on it for soda fountains. All new counters going into their stores this year have been plastic laminated; Warner Brothers have modernized a great

A REINFORCEMENT!... SEMI-CURED* PHENOLITE, PUNCHED TO SHAPE, THEN FORMED AND HARDENED IN COMBINATION WITH BAKELITE MOLDED...OPENS UP A BRAND NEW FIELD OF OPPORTUNITY IN MODERN PLASTICS

Fuse Puller and Line Tester, illustrated through courtesy of Star Fuse Co., New York. Weighs only four ounces.

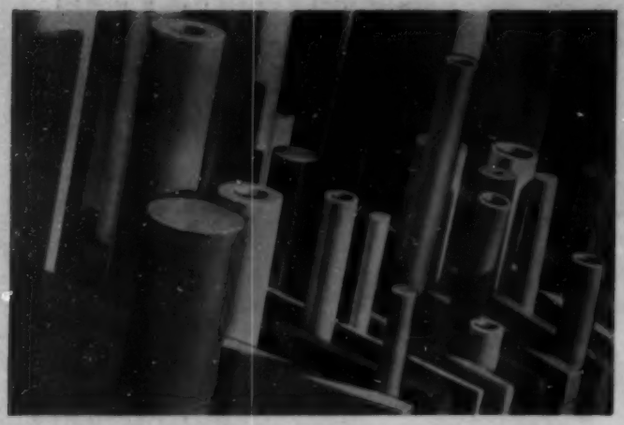
Strength — where strength is needed . . . In this Fuse Puller and Line Tester, Bakelite Molded is reinforced with a piece of semi-cured Phenolite to insure adequate mechanical strength under every shock and strain . . . the starting point for an entirely new field of uses.

Nearly every day, somebody, in some industry, working with our engineering department, finds in the properties and characteristics peculiar to Phenolite and/or National H•A•R•D Vulcanized Fibre a new short cut, betterment or economy in product or plant equipment.

NATIONAL VULCANIZED FIBRE COMPANY, *Wilmington, Del., U. S. A.* (*Offices in Principal Cities*)

NVF

*Phenolite is the registered trade-name covering all NVF formulae for laminated bakelite.



Dilecto...

THE MOST ADAPTABLE INSULATING MATERIAL

You can do things with DILECTO (phenol fibre) a laminated plastic, not possible with other plastic products.

DILECTO possesses unusual insulating and mechanical properties; it is resistant to moisture, acids and oils. It is about half the weight of aluminum. It can be had in mirror-like or dull satin finishes and in color effects. It will withstand the roughest, toughest usage. It is amazingly adaptable to practically all machining operations.

We will be glad to send you samples of DILECTO. It is made in sheets, rods and tubes or in parts fabricated to your specifications. We shall also be glad to send you a copy of the complete DILECTO catalog.

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK DELAWARE

CHICAGO CLEVELAND

NEW YORK

Table tops in the tourist lounge "R.M.S. Orion" (above) are of Formica as are the doors (below) in coupon booths, East River Savings Bank, N.Y.C.

many of their theatres with it, using doors, lobby paneling, ticket booths, etc.

Approximately $100,000 worth has been specified for the annex to the Congressional Library where it will be used for wainscot, telephone booths, desk tops, fronts of card index files, and other purposes. It has been specified for doors in the new Federal Reserve Building in Washington. It has been used for doors, wall covering, desk tops, in a number of leading broadcasting stations, the latest being WGN Chicago and WWJ Detroit. On the British liner "Queen Mary" it was used for table tops, stateroom furniture tops, wall covering in all bathrooms, for a cocktail lounge with bar counter, wainscoting, and table tops. A similar use of it was made on a number of other British ships during the past year. The new streamlined trains are usually equipped with laminated table tops in the lounge cars, and frequently with window capping, shelves in lavatories, linings for hopper seats, sliding panels in upper berths. Leading hotels from coast to coast have made a liberal use of the material for counters, table tops, and wainscoting in the new cocktail lounges opened since prohibition was repealed. Department stores have improved the appeal of their beauty shops by application of the material.

MACHINERY and EQUIPMENT

Molding Presses
Extrusion Presses and Molding
Molding Plant Accessories
Finishing Plastic Surfaces
Flexible Metal Tubing
Buffing Wheels
Tumbling Barrels
Pages 245 to 294

Molding presses

BY C. F. BURROUGHS*

IN GENERAL, all presses may be divided into two distinct types by one of their major characteristics. 1.—The fixed stroke type. 2.—The flexible stroke type. The first type is known as a mechanical, crank or toggle press, the second type as a hydraulic press.

The fundamental difference between the two types of presses results in an oddly reversed set of characteristics. On the mechanical press, length of stroke and speed are fixed, but end pressure is indefinite and indeterminable. On the hydraulic press length of stroke and speed are flexible but end pressure is definite and determinable.

The hydraulic press consequently lends itself to the three basal principles in molding: (1) A predetermined unvarying pressure can be applied on the mold and its contents regardless of the thickness of the mold or on sheets regardless of their thickness. The predetermined pressure without the slightest variation can be exerted on the mold or sheets during the chilling period (necessary when molding thermo-plastic compounds). (2) Accurate measurement of applied pressure. (3) Accurate control of ram or closing speed to synchronize it with flow time of material in mold or sheet.

While the invention of the hydraulic press is generally conceded to Pascal in 1653 and the practical design to Bramah in 1795, this machine had relatively little use until the discovery of vulcanizing of rubber by Goodyear in 1839. Since then, practically all thermosetting and thermo-plastic compounds have been molded in hydraulic presses.

Before describing types of molding presses, it might be well to state the molding materials now used are of two general classes—(1) thermo-setting (2) thermo-plastic. Thermo-setting compounds harden under continued heat—an article made therefrom can be removed from a mold without cooling the mold, in a great majority of cases. Thermo-plastic compounds soften under heat and remain so while hot, consequently, the mold must be cooled while under pressure before the molded article can be removed.

Hydraulic molding presses may be divided into five types—(1) Cored Platen. (2) Semi-Automatic. (3) Tilting Head. (4) Angle. (5) Injection Presses. The foregoing covers practically the entire field.

In the thermo-plastic field, extruding presses, blowing presses, dehydrating presses, cake presses, etc., are used for the production of rods, tubes, cakes, sheets, etc.—these types cannot be strictly classed as molding presses.

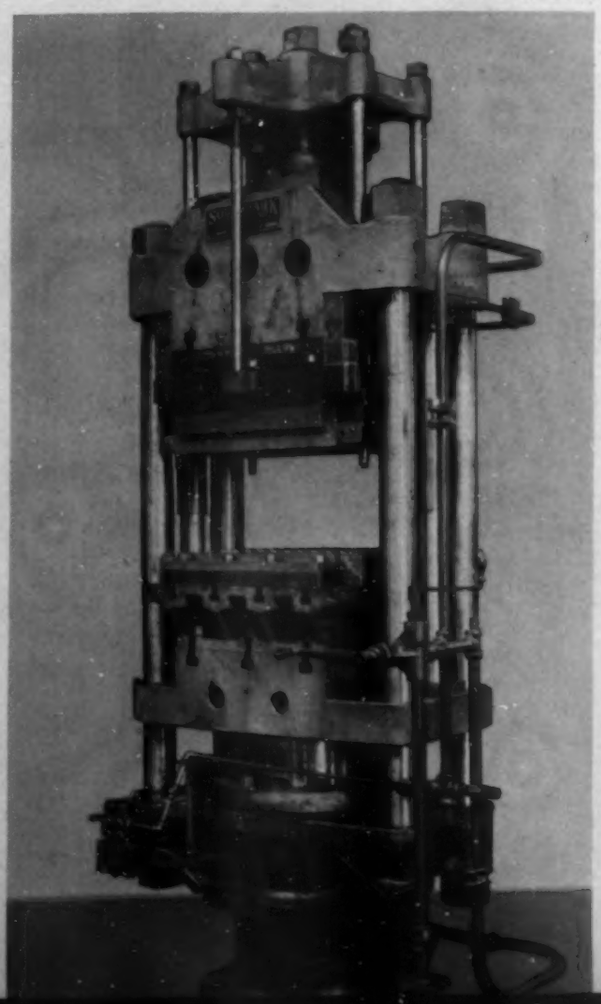
(1) Cored platen press as shown in Fig. 6, is the oldest type—the mold after being loaded, is manually inserted between the press platens through which steam is circulated, the mold and its complement of material are heated through contact with the press platens. This type of press for heavy die molding, is exhausting on the operator and time consuming due to inefficient heating and the necessity of manually disassembling the mold for removal of the molded articles.

However, this type with multiple openings, Fig. 5, is used to manufacture thermo-setting laminated sheets and Fig. 4, for polishing thermo-plastic sheets. In the latter, the platens are heated and cooled while the material is under pressure.

Cored platen presses for sheet molding can be built with unusually large platen areas and the necessary high tonnage, the press shown in Fig. 5 has platens 52" x 208", the surface pressure is 8000 tons on the platens.

(2) Semi-automatic presses as shown in Fig. 3, were the first developed to eliminate handling the molds, also to enable rapid heating and cooling of the molds with their contents. The molds are fastened in the press and are channelled for the circulation of heating and cooling mediums. The molded articles are automatically ejected from the mold cavities. Fig. 1, illustrates the latest design of semi-automatic press—it is the same in principle as that shown in Fig. 3, except the ram moves upward and the ejection of articles is accomplished by independent hydraulically actuated top and bottom rams. This type of press was

1 BALDWIN-SOUTHWARK



* Burroughs Engineering Co.

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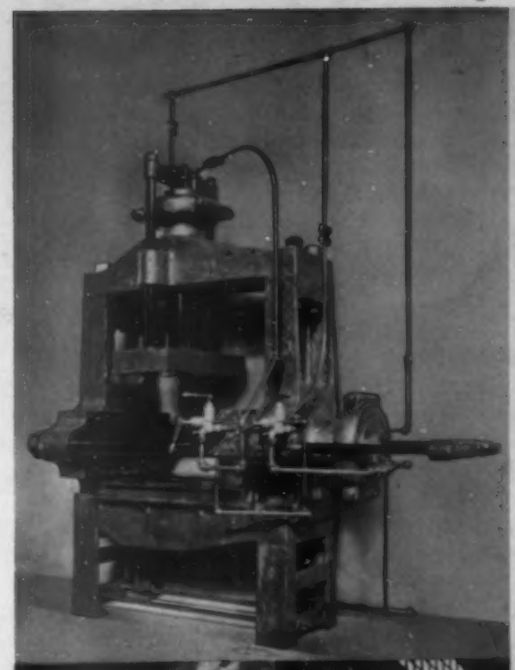

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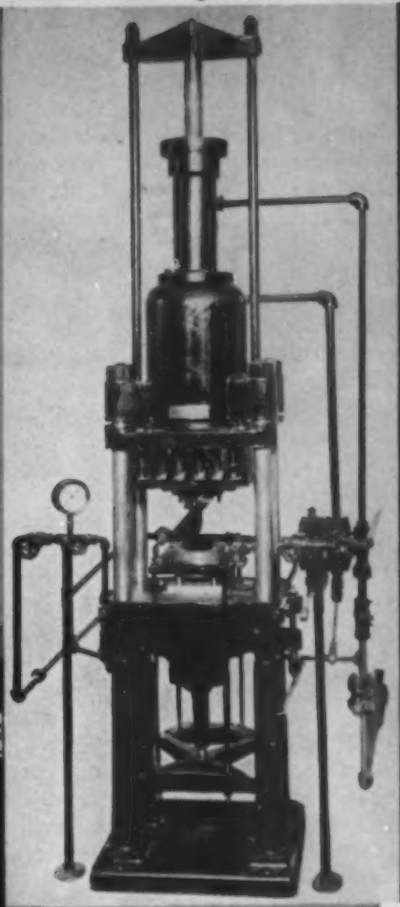

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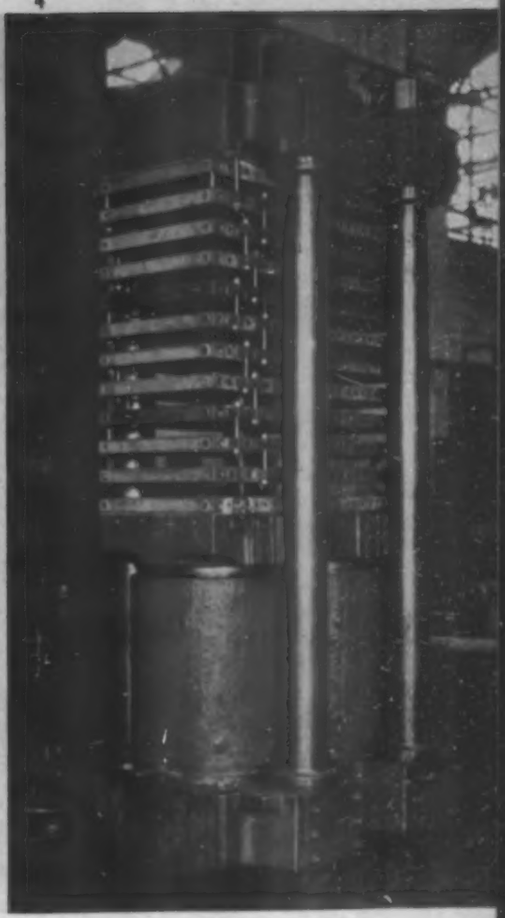
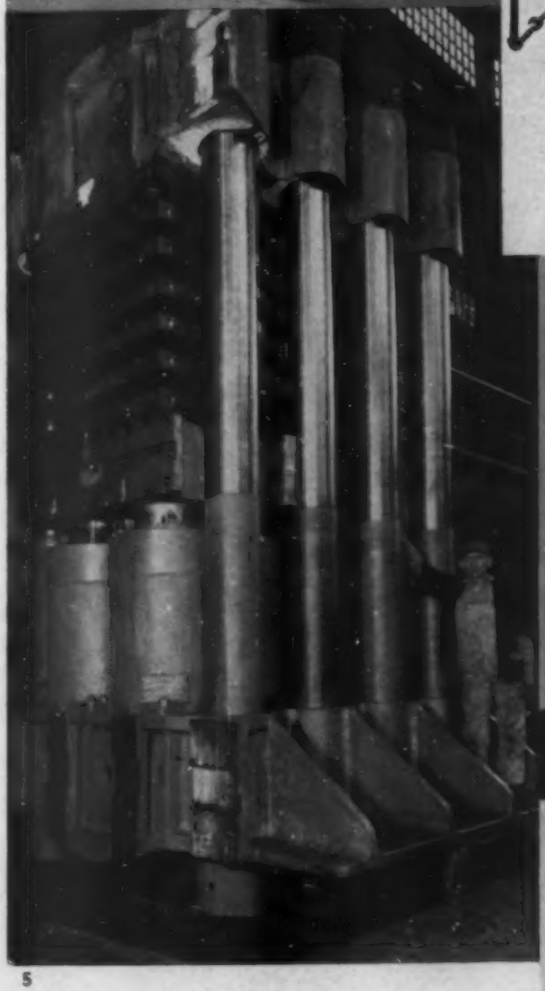


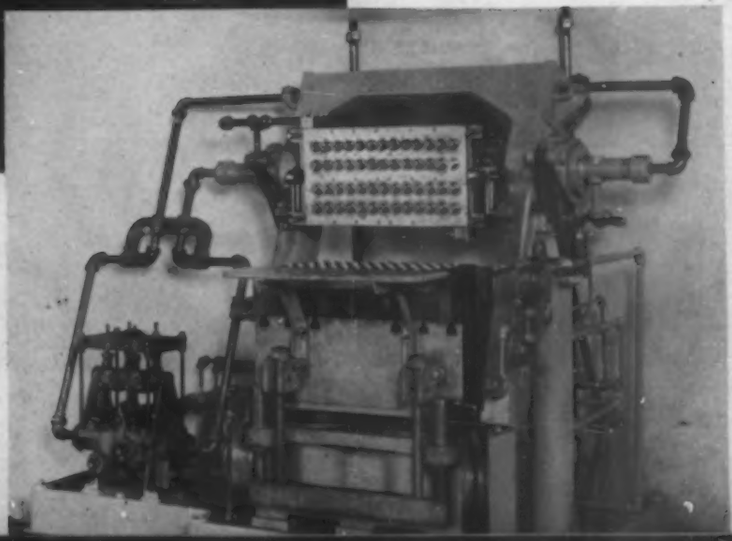


5

6

2. Angle press developed to semi-automatically mold articles having external threads, depressed panels, etc. 3. Semi-automatic press. 4. Hydraulic press with multiple openings for polishing thermoplastic sheets. 5. Cored platen press. 6. Cored platen press, early type. 7. Tilting head press

7



a decided step forward in the molding art. It has but one drawback—the difficulty of inspecting and clearing the top mold plate. Presses of this type can be built of high tonnage and large platen areas.

(3) The tilting head press as shown in Fig. 7, was developed to eliminate the difficulty of inspecting and cleaning the top mold plate. The head rotates 90 degrees, bringing the upper mold plate in full view of the operator. When the head is in this position, the lower mold plate is also accessible for placing inserts, cleaning, etc. In this type of press, the molds are fastened in the press and directly heated and cooled. The molded articles can be automatically stripped from the forces or ejected from the lower cavities. This type of press is slightly more expensive than the semi-automatic press. It, however, effects a considerable saving in production costs. The latest development in this type permits such presses being built of very high tonnage and large platen areas.

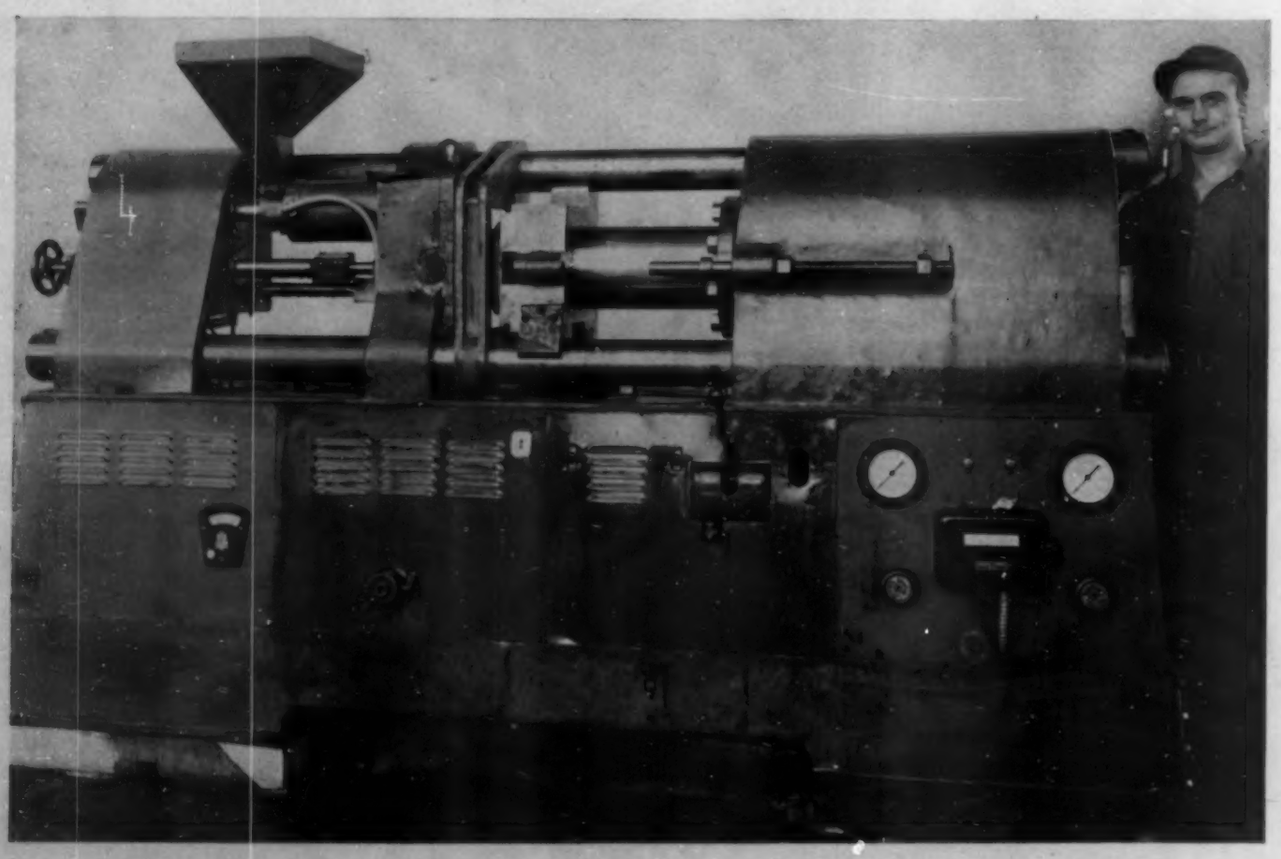
(4) Angle molding press shown in Fig 2, was developed to semi-automatically mold articles having external threads, spools, boxes having depressed panels, etc., all of which previously necessitated the use of split mold cavities held in a retaining chase. Before the development of this type of press, excessive molding costs prevented the use of molding compounds for many applications. The molds are fastened in this type of press and are directly heated and cooled.

(5) Injection press as shown in Fig. 8, was developed for forcing pre-heated thermo-plastic compounds into a closed mold. This method is not new—it has been practiced since 1872. Wide use of the method was handicapped by lack of a molding compound that was not supersensitive to heat. Cellulose acetate and other compounds now obtainable at reasonable prices are ideal for use in injection presses. This method enables large production with a minimum number of mold cavities. The material while in a plastic condition, is forced into the mold under a very high pressure per sq. in.—this tends to force the molds apart, consequently mold areas cannot be large unless the counteracting force is somewhat higher. With the development of presses of high power, this method of molding will probably supersede molding with semi-automatic presses, particularly in the thermo-plastic field.

Molding presses of all types should be designed to eliminate deflection, otherwise, imperfect moldings and injury to the molds are bound to ensue. Space in this issue precludes the description of the many special attachments that can be used with the foregoing types of presses. Recently, compact high pressure pumps have been developed permitting their use on any of the presses described. These pumps give greater flexibility than the old time accumulator systems.

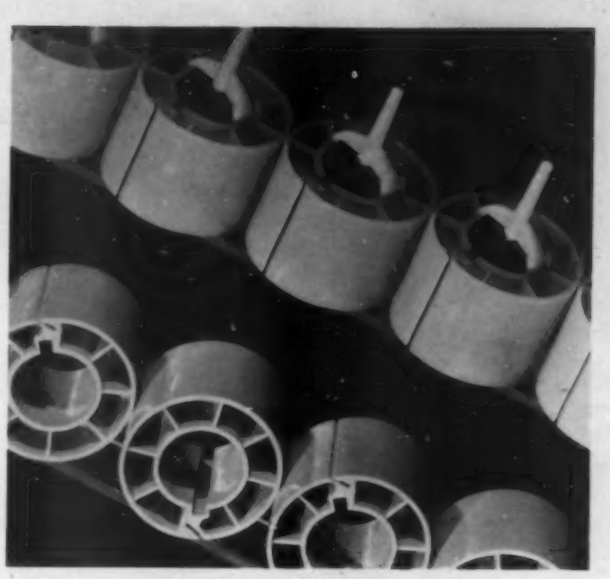
Improved molding presses have greatly benefited the art, but it must always be borne in mind that the best press would be utterly useless without a good mold. As a matter of fact, upon the mold and its attachments depends the success of the operation as to accuracy, finish and speed of production.

8 The new Burroughs Hydraulic Injection press for thermoplastic molding. This process is explained in detail in the following article

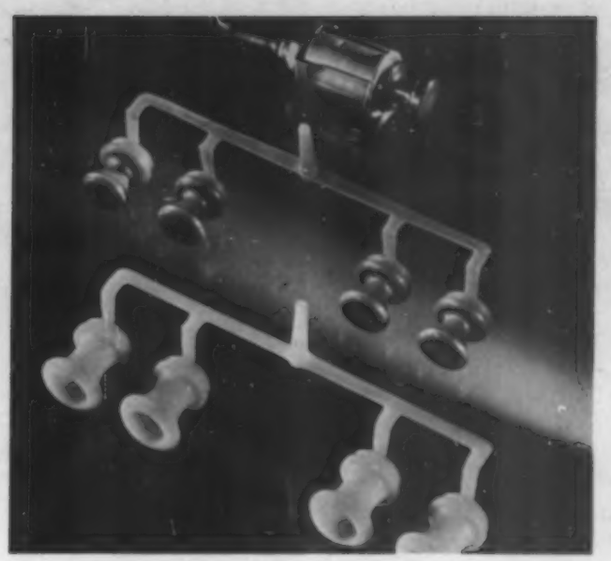


Extrusion presses and molding

BY HOWARD F. MacMILLIN*



Ciné film cores. Those at top show "gates" where material flowed to the mold. (Courtesy Tennessee Eastman Corp.)



Cigaret lighters molded four at a time by rapid injection by Casco Products Corporation

EXTRUSION molding has definitely arrived as a commercial method of producing plastics. With it comes a whole new set of possibilities of intriguing interest both to molder and user. The process and what it offers can best be presented by comparison and contrast with conventional compression molding. In extrusion molding only the last event of the complete plastic molding cycle occurs within the mold cavity; namely, cooling and hardening of the plastic. Of course, in compression molding the entire transformation of the compound to finished article takes place within the mold.

This difference establishes a very definite distinction as to the class of molding material which is handled by the extrusion process. Broadly speaking, extrusion molding is therefore applicable to thermoplastic materials as contrasted with thermosetting resins molded by the compression method. Thermoplastics remain soft under sustained heat, whereas thermosetting materials undergo an irreversible cure after being heated for a definite period.

The extrusion process, which is also frequently referred to as "injection" molding, had its early inception in Europe. As is so frequently true, introducing this new method into this country has called for major readjustments to step production up to the large volume output that we require. This development in both American-made thermoplastic molding materials and extrusion molding equipment has been gaining much headway during the past two years. Now it can be said that the process has reached a practical commercial stage. This is borne out by the fact that a number of molders are already in production with batteries of from two to seven extrusion machines.

With extrusion molding it is possible to produce articles beyond the limitations of straight compression molding. Attention is called to two particular jobs molded by the extrusion method, the illustrations of which accompany this article. One is the mouth-piece of a musical instrument—the other the combination glass and molded frame door or bezel for radio dials.

The mouth-piece for the musical instrument must fit perfectly over the instrument and at the same time provide a precision opening at the end responsible for sound fidelity and control by the player. The exacting requirements of this product will not stand for flexing which is the hazard confronted where it is attempted by conventional methods.

The glass door and its molded frame are practically welded together, the plastic being extruded around the glass to provide an air and dust seal. It would be impossible to accomplish this in the conventional type molding without crushing the glass insert.

It is true that extrusion molding has broadened the scope of plastic forming—but at the same time it must not be overlooked that the extrusion method has made possible decided economies in the molding of products now produced by conventional method.

Extrusion molding advantages

High production through increased speed of operation and the saving of mold expense are the primary advantages of extrusion molding. The cycle for extrusion molding is a rapid one. Unlike conventional

* The Hydraulic Press Manufacturing Company.

molding, there is no curing period during each cycle. Instead, as little as three seconds dwell is all that is required after the mold cavities are filled.

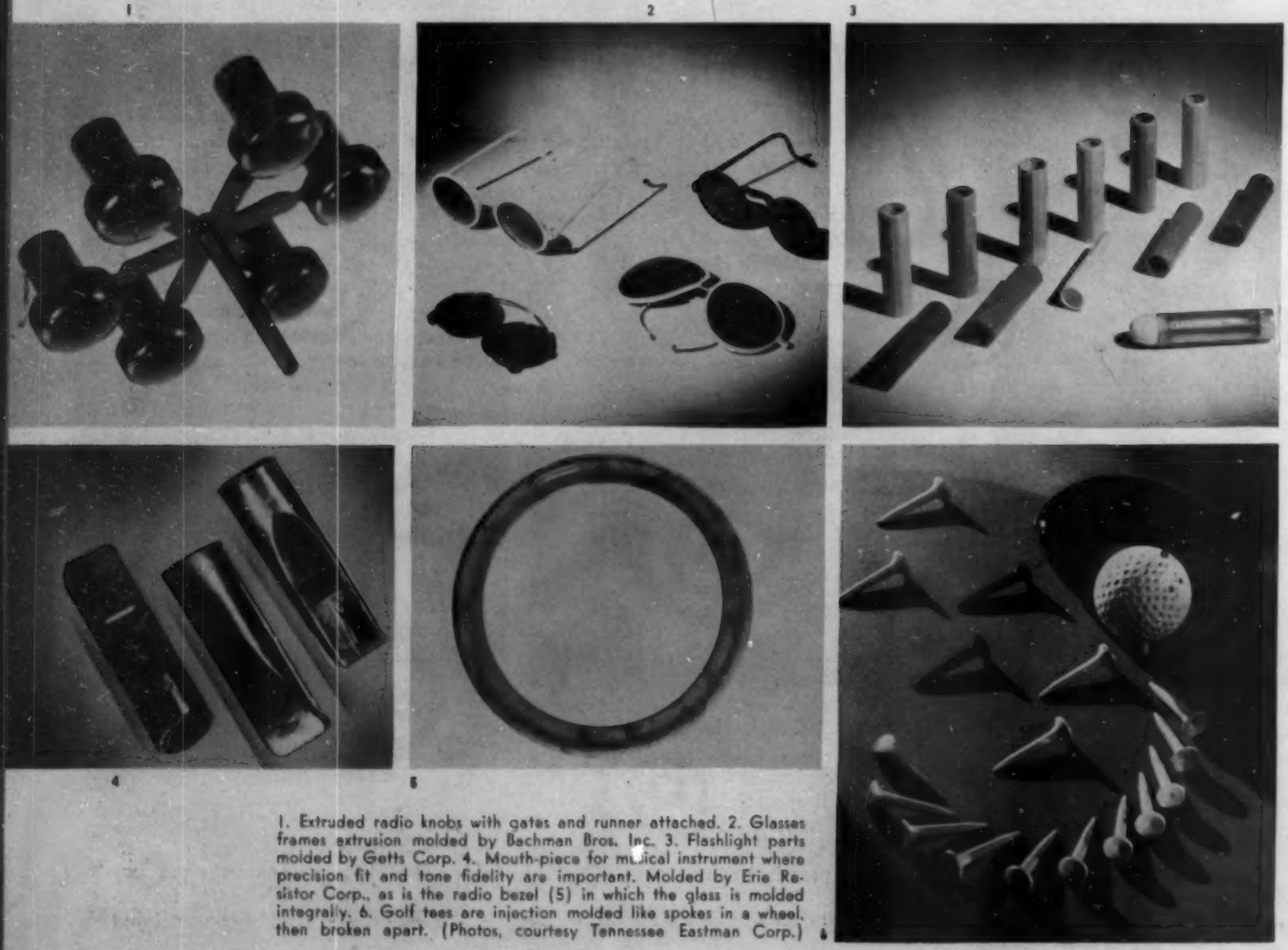
In the molding of adding machine keys, ten of them are made per cycle. There are three cycles per minute which provide an hourly production of 1800 pieces. Where the molded pieces are larger in diameter and of a complicated nature as the knife handle illustrated, two halves are completed per cycle with three cycles per minute—or a total of six pieces.

The savings in mold costs made possible with extrusion molding are a decided advantage in its favor. For instance, an extrusion mold made to produce six impressions per cycle at three cycles per minute would produce 18 pieces per minute—or 126 pieces in seven minutes. These seven minutes compare normally with the time it requires to complete a single cycle by the compression method of molding a thermoplastic. Thus, it would require for the compression method a mold with 126 cavities—which of course is impractical—to achieve the same production or twenty-one times the number of cavities of that required by the extrusion mold.

It readily can be appreciated how much more the 126-cavity mold would cost over the 6-cavity mold. For example, one prominent manufacturer of a complicated molded part paid six thousand dollars for his mold where the conventional compression method was used. His mold cost, by switching to extrusion molding, is now only six hundred dollars—one-tenth the original cost—yet his production has increased materially and the piece in question improved through superior strength and quality.

Of course, this ratio of mold cost is bound to vary with the nature of the product, but a pronounced saving is assured in practically every instance. The handling of these molds in and out of the press is another factor to consider. Because extrusion molds are smaller and lighter, they are easily and quickly handled. No expensive hoisting equipment is required. Still another saving is the elimination of the flash peculiar to compression molding. While a certain amount of surplus material accumulates in the gate and runners through which the mold cavities are fed, this can be used over again in conjunction with a definite percentage of new material. By avoiding a flash there is also a saving due to decreased finishing costs.

The extrusion process saves in labor costs, too. The manually operated extrusion machine is capable of delivering more castings per operator than the conventional molding press because of the fast cycle. This



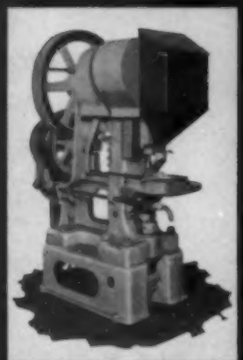
1. Extruded radio knobs with gates and runner attached. 2. Glasses frames extrusion molded by Bachman Bros. Inc. 3. Flashlight parts molded by Getts Corp. 4. Mouth-piece for musical instrument where precision fit and tone fidelity are important. Molded by Erie Resistor Corp., as is the radio bezel (5) in which the glass is molded integrally. 6. Golf tees are injection molded like spokes in a wheel, then broken apart. (Photos, courtesy Tennessee Eastman Corp.)

NEW PREFORMING PRESSES
NEW PREFORMING METHODS

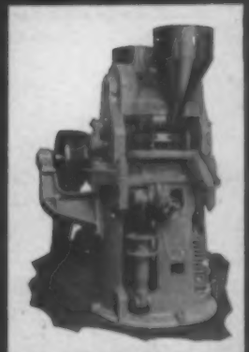
FJS

"DDS-2" Preforming Press. Production: 350 per minute. Maximum preform diameter, 1-3/16"; maximum depth of fill, 2".

"R" Preforming Press. Production: 40 to 50 per minute; maximum preform diameter: 2½"; maximum depth of fill: 2".



"DD-2" Preforming Press. Production: 500—600 per minute. Maximum preform diameter, 1-3/16"; maximum depth of fill, 1-1/16".



The single punch and the two rotary presses shown are three of the new and rugged Stokes models built specifically for the severe service of preforming work. Better preforms at less cost and improved methods are made possible by the design of these presses which includes numerous new features.

Typical features common to both single punch and rotary models are semi-steel construction, adjustable Automatic Excess Pressure Release which prevents jams and undue strain, outboard roller bearings and compact direct motor drive.

New methods to which these machines lend themselves include the making of ball-shaped preforms to facilitate handling and possible preheating to lessen the curing time. Rotary presses with their potential output of 225 to 600 per minute are especially adapted for making ball or convex-faced preforms most economically. Such preforms can be used in multiples to replace large single preforms of irregular or round shape since they crush readily to powder, eliminating any marks on the finished piece.

Rotary presses, also, have the added advantage that they can be operated economically on limited output. By using a partial set of punches and dies—as few pairs as the job requires—the same production is possible as on a single punch press making smaller pills of the same diameter, while retaining the added flexibility and reserve capacity.

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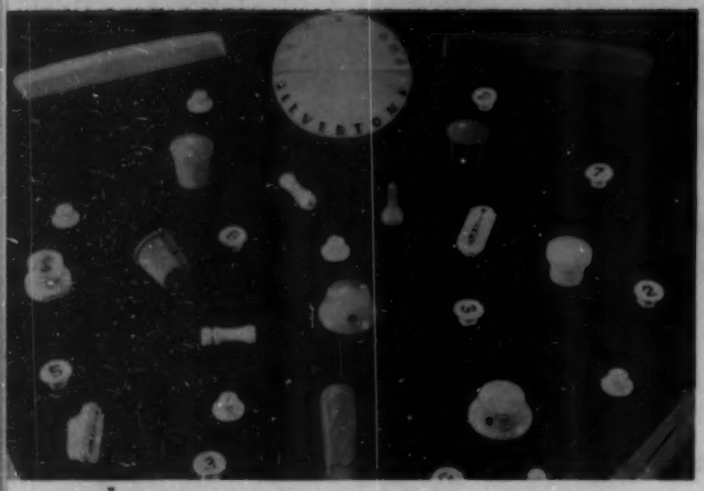

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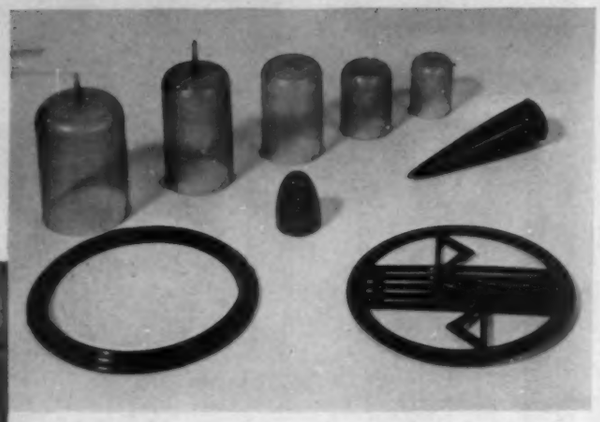

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7. A group of plastic parts injection molded by Erie Resistor Corp. 8. The grille in this radio is injection molded by Chicago Molded Products. 9. Tenite parts injection molded by The Getts Corp. 10. Large knife handle extruded in two parts at the rate of six pieces per minute by Erie Resistor Corp.

is emphasized with automatic control where it is possible to maintain a slightly faster cycle and with a die designed for full automatic operation it is possible for one operator to serve two machines. Thermoplastics are molded by the extrusion method with highest thermal efficiency, because temperature conditions are stable throughout the cycle, the heating chamber and the chilled mold remaining at their respective temperatures constantly. Thus the heat loss of alternate heating and chilling of the die, as in conventional molding of thermoplastics, is avoided.

The material

The plastics now available for regular extrusion molding include cellulose ethers, esters, vinyl and acetate compounds. These thermoplastic materials progressively soften at from 250 deg. F. to 450 deg. F. The proper extrusion temperature lies within this range, depending upon the grade of material, and its degree of plasticity. Since cellulose acetate plastics are the most widely used compositions, these will be used as a basis for describing the application of extrusion molding.

Being a comparatively new development in this country, extrusion molding called for special research on the part of material producers. Materials for compression molding reached a high state of perfection some years ago, but it was practically necessary to start at the beginning to build up to the point where a thermoplastic containing all of the vital advantages of strength, toughness, resilience, uniform texture, high luster, high dielectric and an unlimited array of pleasing colors was established. In the meantime, the thermal aspect—the preheating and free flow of the material into the mold—was the determining factor for its future success and the basis for its fundamental qualifications.

In establishing their goal, manufacturers of thermoplastics also considered the materials from the consumer point of view, in that such conditions as combustion, freedom from odor or taste, skin contact, heat dissipation, and the effect of oils and acids on the material have all been given due attention and in most instances have become the basis of salient sales features in the promotion of plastic molded parts.

Extrusion molding procedure

As stated at the outset, in extrusion molding only the cooling and hardening *(Continued on page 290)*

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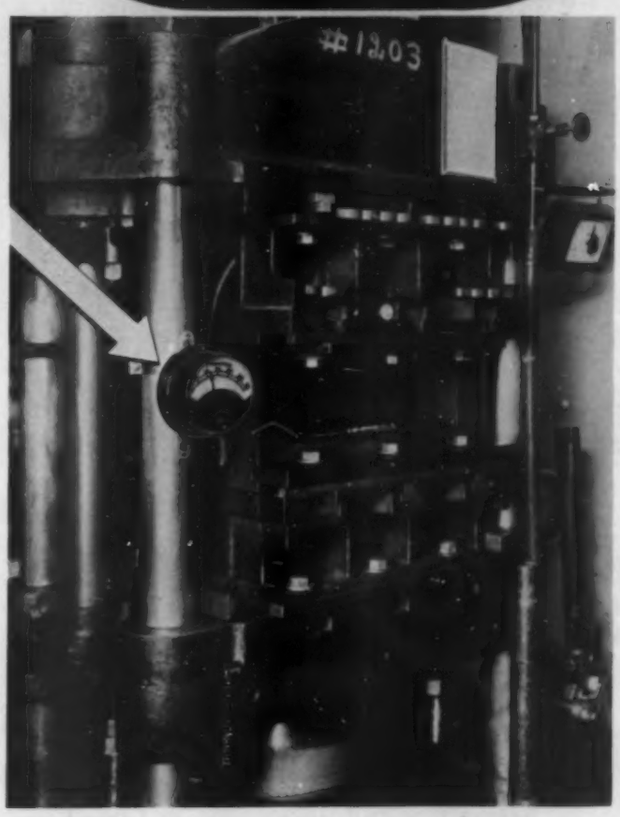
—END UNDERCURES

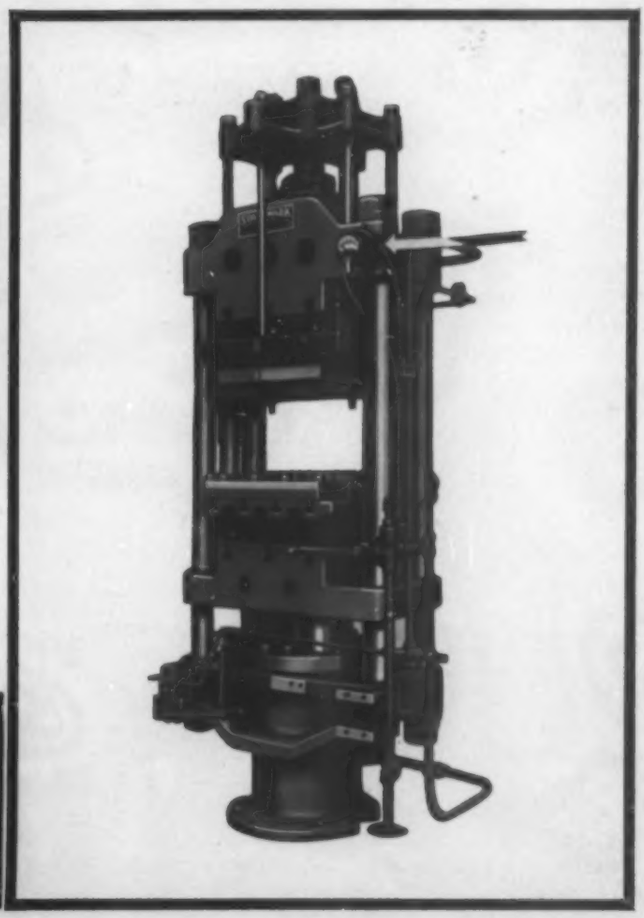
Above: The "Alnor" Self contained, Pyrocon-portable. Specially designed for molding work, its light weight and easily read dial make for convenience in the busy or crowded plant, quickly returning the small purchase price in time and material savings. Hundreds now in use.

Below: Typical "Alnor" two-point installation on a Southwark Press. The two thermo-couples with flexible cables permit temperature readings of either upper or lower platen at the will of the operator, merely by turning the selector switch on front of pyrometer. "Alnor" Pyrometers in either hand or permanently mounted types, are to be found in many modern molding plants, giving accurate service year after year, with minimum investment and little upkeep cost.



Above: A permanently mounted single point "Alnor" Pyrocon, installed on a press in the plant of the Chicago Molded Products Company, with the element inserted in the die providing continuous temperature readings. Note ease with which dial can be read by operator. Note, also, simplicity of instrument and method of installing.

Send for full details about the "Alnor" line and Free Descriptive Booklet



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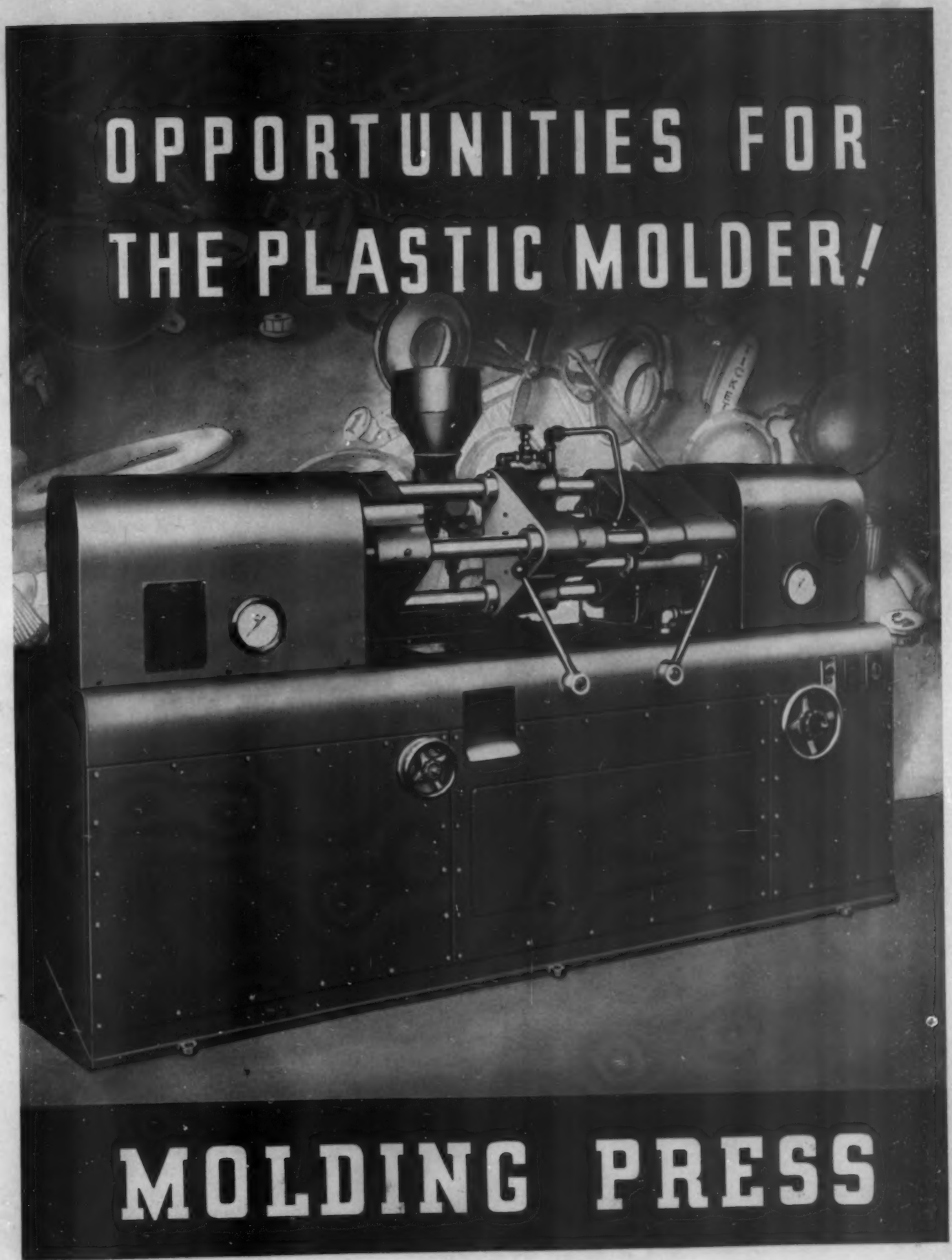
OPPORTUNITIES FOR
THE PLASTIC MOLDER!
MOLDING PRESS

Molding plant accessories

BY HERBERT CHASE, M.E.

MOLDING shop equipment is likely to be thought of largely in terms of presses employed, but those familiar with the operation of such shops know well that with presses alone no shop could function. Supplementary equipment therefore deserves and receives much attention and will be considered in outline in this article.

Although many modern presses today are self-contained units, so far as mechanical or hydraulic operation is concerned, the more commonly used presses are dependent on a separate hydraulic system which is an important part of the shop equipment. Presses must also be supplied with means for heating platens and molds and this commonly requires a steam boiler with a suitable piping system for supplying each press. Air pressure is required for blowing dust and flash out of molds and sometimes for operating parts of the presses or in conjunction with hydraulic accumulators, hence most shops have one or more air compressors and a system of piping air to each press. A low-pressure water system is often needed for closing presses and sometimes for mold cooling, and if main pressure is not employed or if water must be conserved, a low-pressure pumping system is provided in addition to the high-pressure hydraulic system. Some shops also have a dual high-pressure system, say for 1,500 and 3,000 lbs. It is thus evident that much supplementary equipment is required before molding presses can be operated.

Considerable equipment is also required in preparing molding compounds for use in molding, though usually except for pilling, the compounds are purchased ready for use. In general, the compound must be weighed out or otherwise measured prior to use. In consequence, weighing scales and volume measuring equipment is needed. Frequently, for rapid handling and convenience, tableting or pilling machines must be employed, some shops having three or four different types. Weighed charges, sometimes measured on automatic scales, are commonly placed in cups or bags, which in turn are delivered to presses in trays, buckets or tote boxes. At the press, it is often necessary or desirable to pre-heat the charges fed to the mold and this requires warming ovens or platens heated to the desired temperature. If, as in some types of molding, sheet stock is employed, this must usually be cut to size, if not so furnished by the plastic producer. Shears, punch presses or other equipment are required to cut it prior to molding. All the operations mentioned in this paragraph therefore require some investment in carefully chosen equipment.

It is often said that molded articles come from the mold ready for use, but in reality the cleaning, inspecting and shipping departments of molding plants sometimes require as much space as the molding department itself, and considerable equipment besides. Tote boxes or other equipment, sometimes involving belt or chain conveyors, are needed to transfer moldings

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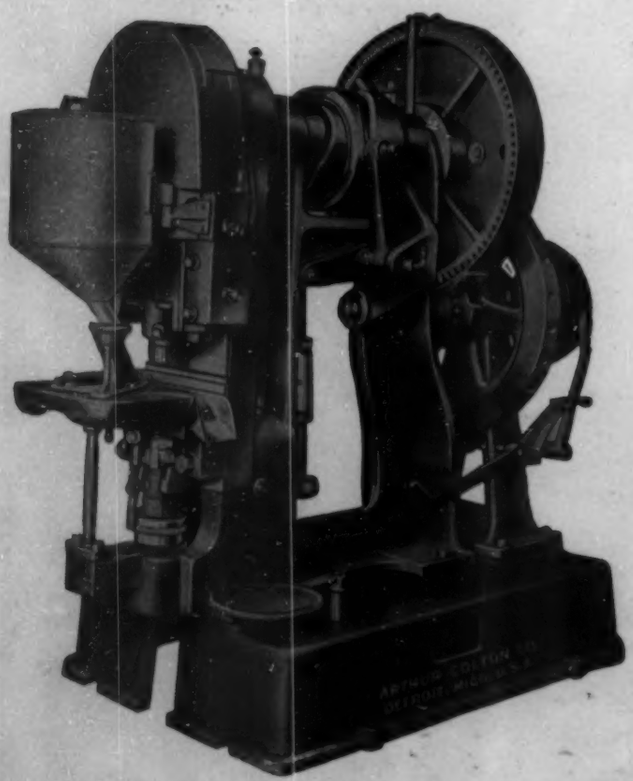

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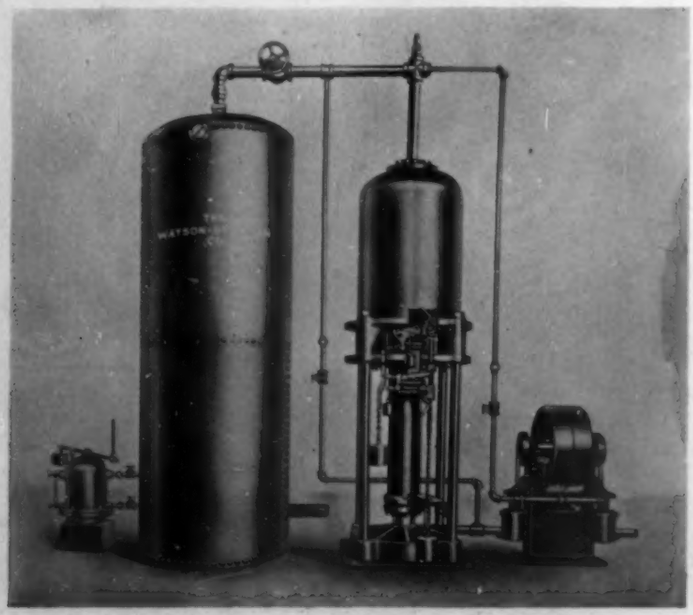

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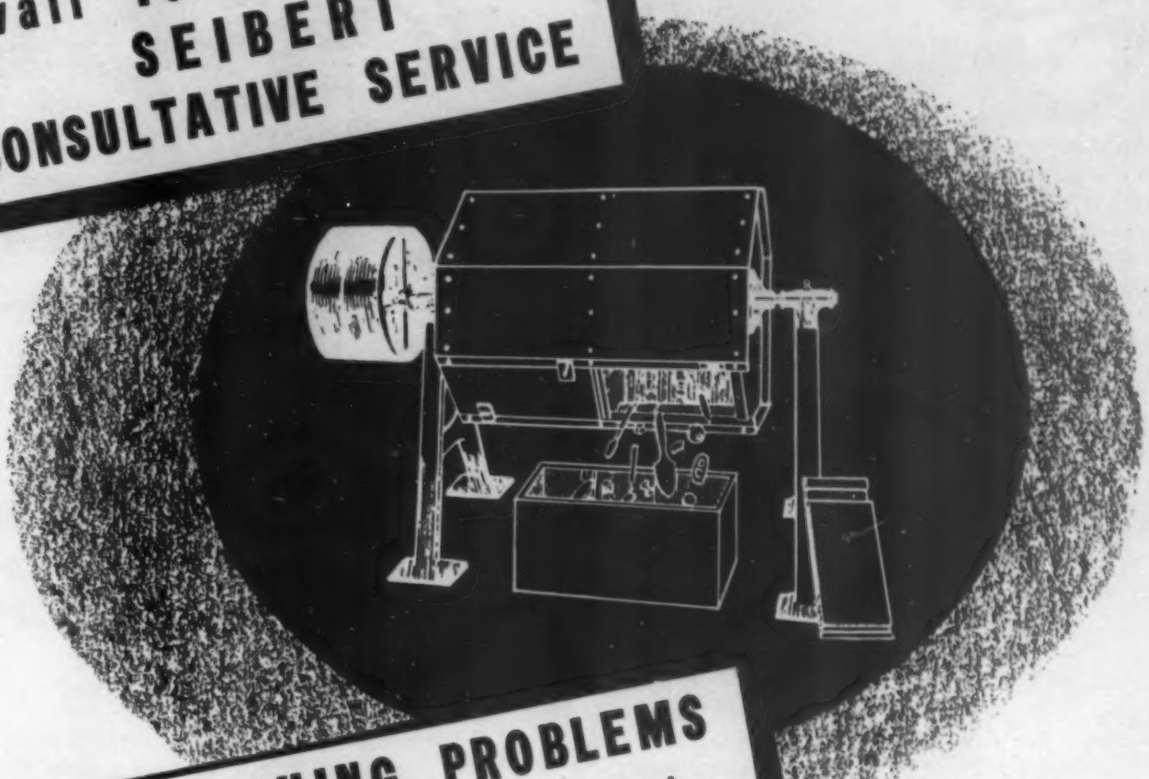

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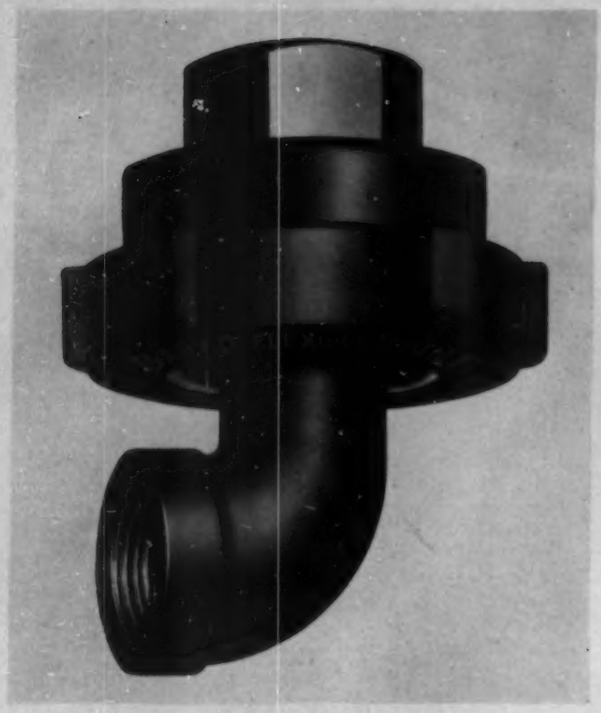
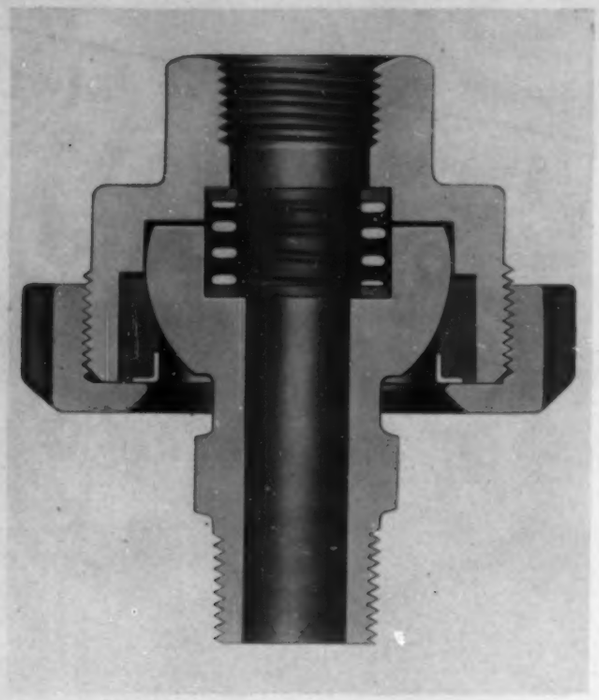


An important unit in many steam-heated presses is the swing joint such as this one made by Barco Mfg. Co.



Cross section of a Barco swing joint showing the flexible joint and its rigid construction so essential to its efficient performance

from presses to cleaning departments and in the latter considerable light machine equipment is usually employed. Drill presses, punch presses, belt sanders, lathes, grinding and polishing wheels, tumbling barrels and various special machines are among those found in cleaning departments. Gages and other measuring instruments are employed for inspection, and packing usually requires equipment for feeding moistened gum paper and possibly other packaging equipment.

Quite aside from all the foregoing, nearly all sizable molding plants have tool rooms in which molds are produced and kept in repair. Such departments require precision machine tools, which need not be listed here, but which involve a large investment and are of great importance to the successful operation of a molding plant.

In addition to building molds, it is necessary to have equipment for handling them, setting them in and removing them from presses and for storing them safely when not in use. Overhead cranes are used for handling large molds and sometimes for shifting presses about, but in most shops less expensive, hand-operated equipment is adequate. In large molds as well as those of smaller size, the major portions remain fastened to the press platens during molding operations, but in many shops hand molds are still employed. Such molds are usually removed complete from the press for opening and are deposited on adjacent benches where the molder takes them apart, removes the molding, places inserts when required, fills the mold, assembles it and returns it to the press. Hand-operated arbor presses are frequently needed for taking hand molds apart and are an important item of equipment. If moldings must be cooled in the mold to prevent warpage, hand molds must be transferred to cold presses for cooling, or the molding press must be operated on alternate heating and cooling cycles. Thus many shops have light cooling presses in addition to those in which molding is done.

Some types of hot moldings and all cold-molded products require baking subsequent to molding, and curing ovens, often with automatic heat controls, are essential and require considerable investment as well as much space. In the process of molding, molders often require several hand tools and sometimes special tools for aiding in the removal of moldings from molds without injury to the moldings or molds. Some molds of the automatic type have loose parts which must be removed by hand. These are usually heavy and must be pulled out onto a short section of roller conveyor placed at convenient height. Frequently, in starting work with a new mold and sometimes even during production, a pyrometer is employed to make sure that the mold temperature is kept within required limits. Nearly all presses are equipped with hydraulic pressure gages to indicate that pressure is properly maintained, and steam gages showing the steam pressure, which in turn is an important factor in controlling mold temperature, are fitted to the steam line at many presses. As the time of molding is important, automatic electric and other clocks are frequently supplied at each press or group of presses.

In shops molding white or light colors, precautions are required to keep dust and other foreign matter out of molds and molding compounds. Presses using such compounds are preferably isolated from those molding dark colors or are at least separated by screens of fabric. In some of the most modern shops, all air entering the molding department is filtered and

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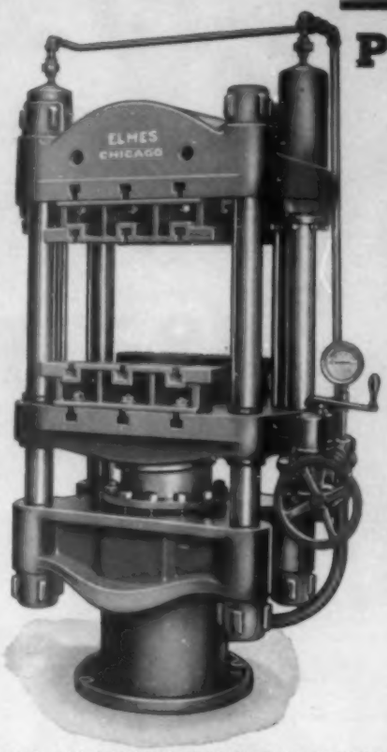
PLASTIC MOLDING EQUIPMENT



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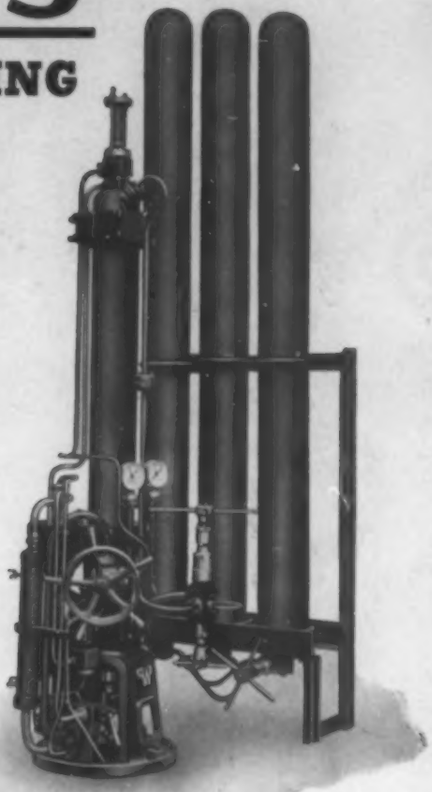

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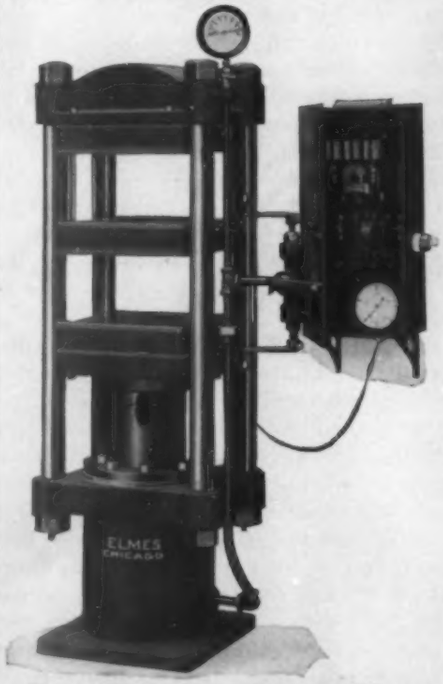

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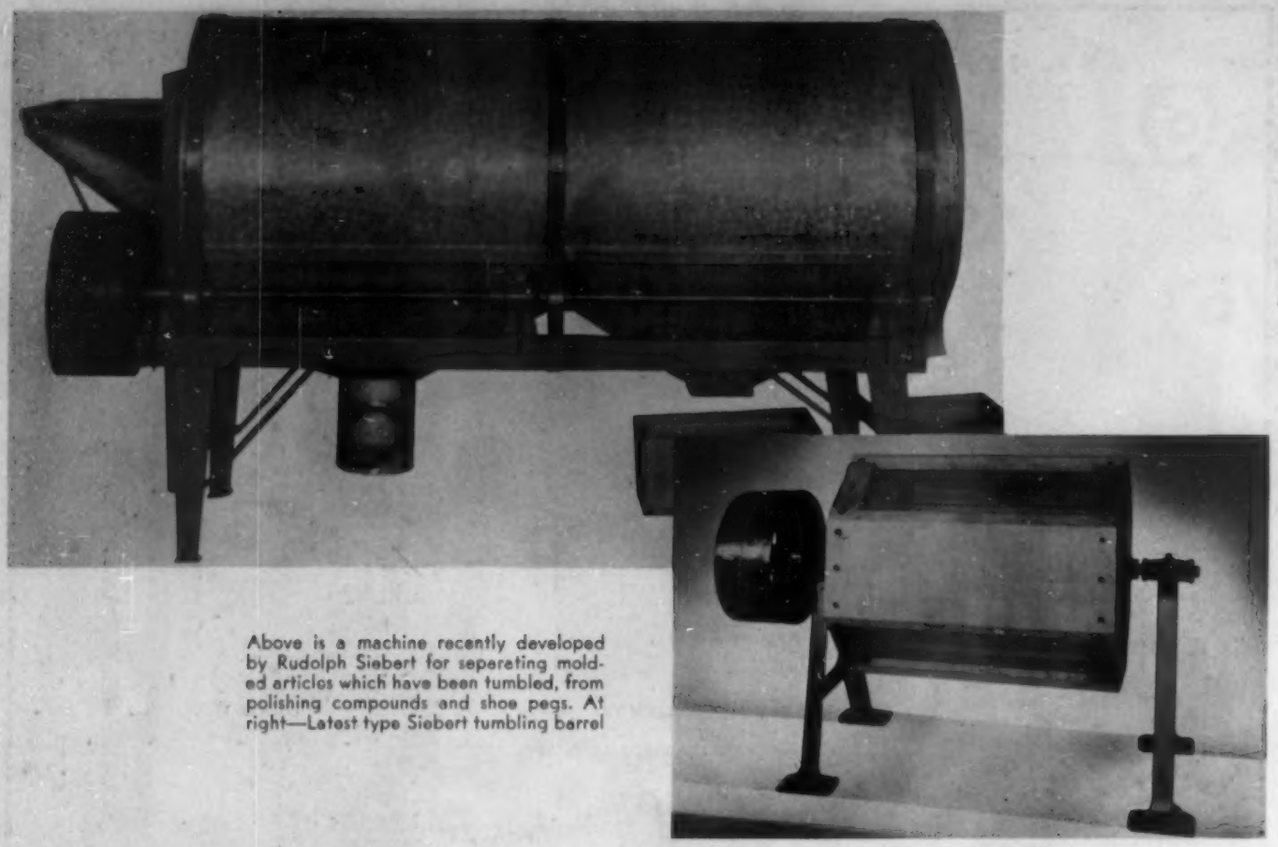


Above is a machine recently developed by Rudolph Siebert for seperating molded articles which have been tumbled, from polishing compounds and shoe pegs. At right—Latest type Siebert tumbling barrel

changed frequently to exclude dust and maintain suitable working conditions for operators. This requires a good ventilating system and one for maintaining proper air temperatures.

An adequate lighting system is also essential, especially as many shops operate on two or three shifts, good artificial lighting is needed. Incandescent and mercury vapor types of lighting are generally employed. Much the same might be said of any production operation, of course, but the fact remains that a good lighting system is far from being an inconsequential factor in the equipment of a molding plant.

This, in outline, gives a general picture of the equipment needed in a modern molding plant, aside from the presses themselves. It remains to examine in some detail the various types of equipment in more or less common use.

Hydraulic systems

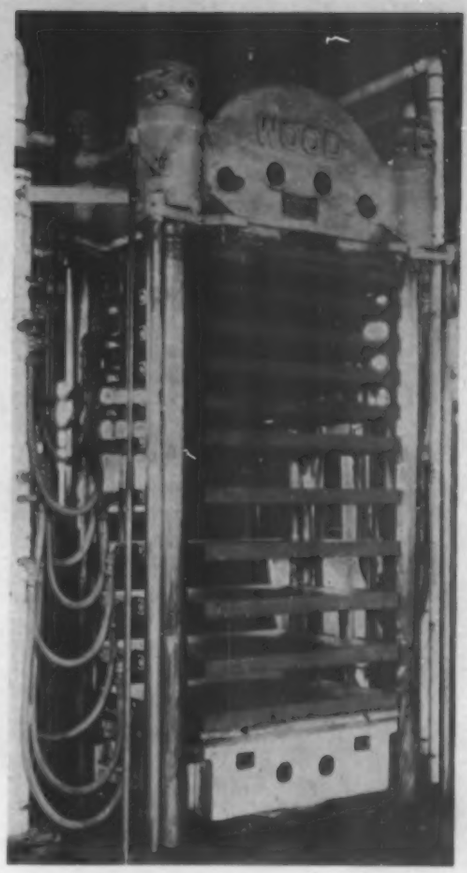
The central feature of the high-pressure hydraulic system for any molding plant in which several presses are operated from a single source is a high-pressure pump. There are numerous designs of such pumps, but the majority are piston or plunger types, either vertical or horizontal, and usually designed for drive from an electric motor unless high-pressure steam is available, in which case the pump may be directly steam operated. Even in the case of steam-operated pumps, however, an electrically driven stand-by pump is often installed. Large plants sometimes have a complete stand-by hydraulic system which can be placed in operation quickly and thus avoid shutdown of a plant in the event that trouble with one system is encountered. Besides the reciprocating type of pump, rotary types for extra high pressures are also available.

It is necessary, of course, to vary the pump output in proportion to the demand for high-pressure liquid, hence control devices for stopping or unloading the pump when the system is full and up to pressure are required. To increase the momentary capacity of the system by providing a limited storage of high-pressure liquid, and to minimize pressure fluctuations, it is customary to install a hydraulic accumulator, or more than one. These are of two general types, namely, those having a weighted cylinder or ram, arranged to rise and fall as the quantity of liquid in the system varies, and those in which air under pressure provides the load. The latter type has several advantages and is gaining in use.

Highly important in the hydraulic system are the control devices for starting, stopping or unloading the pump or pumps and the various valves required, including those for controlling the admission and exhaust of liquid from the presses. These are of many types and designs and, being subject to high pressure and wear, such valves often involve considerable maintenance work. For satisfactory operation, they must be well built and are important in molding shop equipment and investment.

To minimize the consumption of high-pressure liquid, it is common practice to close presses initially and to open them by using water at low pressure from city mains. When presses are substantially closed, the valve to the city main is closed and high-pressure water is admitted for final closing of the press. When the press is opened, the water is often run to waste, but it can be largely conserved if a self-contained low-pressure system is used. (*Continued on page 284*)

ECONOMIZE



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Cut the "P.M.P." Seamless Flexible Metal Hose, which is supplied in long lengths, to the desired length and slide on the fittings part A. Slip the braid back at B and screw on the threaded split ring C until the hose projects 1/2 in. to 1 in. beyond the end of the ring as at D. Bring part A toward C until it comes against the braid around C, place in a vise and tap the end of the hose with a hammer to compress the projection D until the hose corrugations are closed flat against C. Slide nut E over male end F and screw E on A to bring F tight against D and to push C into its taper seat in A. Part E can then be loosened slightly to allow F to swivel as in a union.

Result—"P.M.P." Solderless—Brazeless—Packless, Self-applied fitting. Patents granted and pending.

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Finishing plastic surfaces

BY J. DELMONTE

PLASTIC products owe much of their popularity to the pleasing appearance afforded by the smooth, high luster surfaces. This attractive gloss, augmented by the depth and richness of the color, lends to the sales appeal of the article. Custom molders have found that a high quality finish stimulates trade and helps them to better meet competitive prices. Proper finishing methods are applicable not only to molded objects, but also to laminated and cast plastics. As a matter of fact, small articles machined from cast plastics require a more intensive finishing treatment than molded products. As far as laminated products are concerned, the improved water resistance of a smoothly finished surface, as compared to a dull, sanded surface, is an added benefit of good finishing.

The finishing of plastic products is a subject about which very little information is available. Many of the current finishing procedures have been borrowed directly from the metal finishing industry. This adaptation is a natural course of development, since much can be learned from the experience of the metal trade. However, it should not suffice as a stopping point, for the proper finishing of plastic materials requires methods and materials not common to the metal finishing industry. By an intelligent application of principles based upon a scientific study of the problem, much can be done to relieve the shop of "cut and try" methods. It is proposed to examine the scientific principles of finishing plastics, first by a basic study of the problem, and second, by a survey of the methods which have proved successful in the polishing of plastic products. It will be necessary to distinguish between finishing methods for small molded and cast articles, and larger laminated, cast, and molded products, as decided differences exist.

At this point, it appears desirable to define a few of the finishing terms which are used, as the terms are applied rather loosely in the industry.

Roughing operations

a. Sanding: Sanding is an operation for rapid *cutting-down* of a surface, by a fine abrasive polishing wheel and various abrasive papers. In tumbling a harsh abrasive mixture is used.

b. Ashing: The application of a coarse abrasive to a buffing wheel and tumbling with a medium abrasive mixture constitute ashing operations.

Polishing operations

c. Buffing: The application of a fine abrasive to the buffing wheel or fine abrasive mixtures to the tumbling barrel give to the article a smoothly finished surface. This is sometimes the last operation, depending upon the degree of gloss desired.

d. Coloring: The term coloring is indicative of the final finishing procedure, whereby a high luster or high gloss surface is obtained.

Polishing wheel: A polishing wheel is made up of successive layers of glue and abrasive, and is used only in sanding operations.

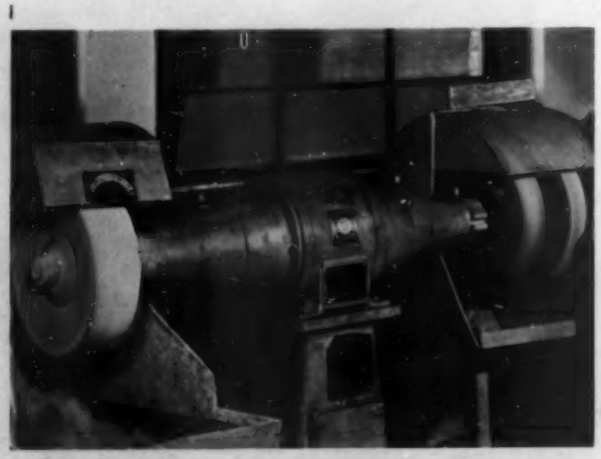
Buffing wheel: A buffing wheel is a cloth wheel to which the abrasives are applied by hand.

Tumbling barrel: The tumbling barrel revolves with the mixture of abrasives, friction elements, and articles tumbling helter-skelter over one another.

Tumbing processes are the most economical operations for large quantities of small, well rounded plastic articles. For large objects the more versatile polishing and buffing wheels are utilized. Likewise, articles whch are limited in quantity or which possess sharp edges and fragile walls are finished better on a buffing wheel by hand.

A typical buffing and polishing lathe used for finishing plastics is shown in Fig. 1. The spindles which hold the polishing and buffing wheels, extend a considerable distance from the bearings, so that the wheels will be easily accessible from either side. It is important that the machine be well balanced to eliminate vibration of the wheel when it is in contact with the work. The wheels are manufactured separately from various canvas, muslin, felt, or flannel materials. In the various operations which are discussed later, muslin wheels are used in the majority of cases. A number of manufacturers have found it convenient to prepare their own buffing wheels, but for the inexperienced and those not equipped with the proper cutting tools and sewing tools, there are a number of buffing wheel manufacturers.

In the finishing of plastics, care must be exercised not to burn the surface of the article being held against the wheel. When the surface is overheated the plastic softens and the surface becomes undulated by the individual buffing discs, giving a wavy uneven



Three wheel polishing machine used for removing fins and other molding and fabricating marks from finished parts

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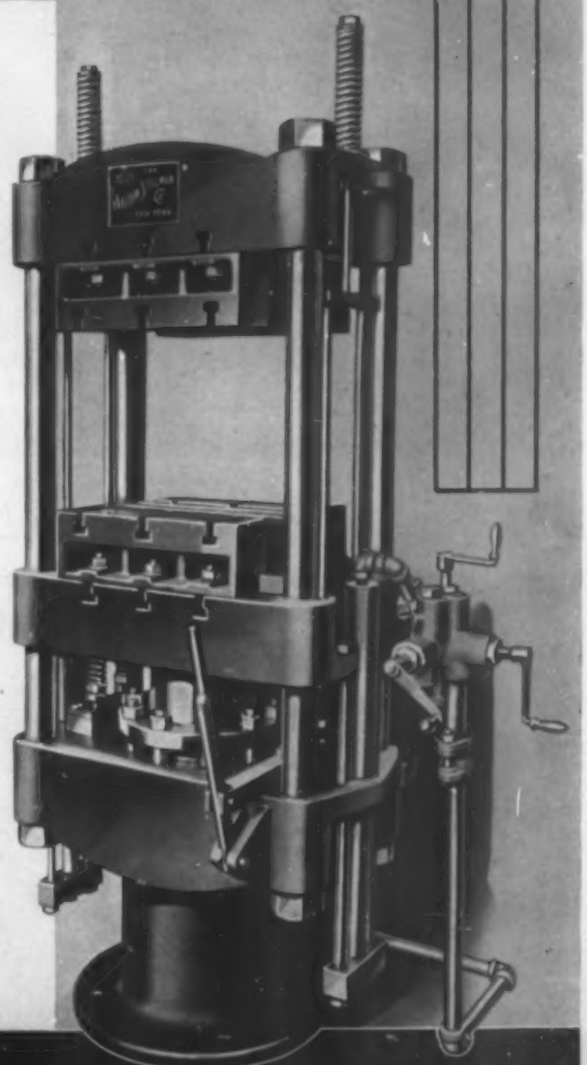
We are prepared to furnish complete hydraulic installations, Presses, Pumps, Accumulators, Valves and Fittings.



THE WATSON-STILLMAN CO.

118 ALDENE ROAD

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appearance which is a blemish upon an otherwise smooth surface. The temperature rises very rapidly upon an article held against a revolving buff, and it takes only a few seconds to reach the maximum safe temperature limit of 300 deg. F. of the majority of plastic products. This precaution against the overheating of surfaces is an outstanding requirement for plastic products. This danger may be avoided by the proper selection of buffing wheels and the correct finishing technique.

In the great majority of buffing wheel operations on plastic products, a *soft* cloth wheel is required. A wheel of this type is obtainable by the following devices:

1. Thick sections of sewed buffs.
2. The use of spacers between the buffing discs.
3. Widely separated rows of sewing.
4. Long stitches.
5. Small end supporting washers on the assembled wheel.

A soft wheel not only has a lower rubbing friction than a hard wheel, which lessens the possibility of surface burning, but it also lends itself more readily to the finishing of small objects with a curved, uneven surface. The buffing wheel should afford a wide surface against which the work can be held; for small objects it should be wider than the over-all size of the piece being finished. In addition, a large width insures better ventilation and hence, better heat dissipation from the surface of the wheel. A good average width lies between 3 and 4 inches for all general purposes.

The correct surface speed of the buffing wheel is another important factor in finishing operations, as the heat generated is a function of the speed. There is no hard and fast rule for determining the proper speed, and consequently a general table is given herewith, which has been compiled from the recommendations of various manufacturers. The chief factor limiting the surface speed is the maximum safe temperature the synthetic resin can withstand.

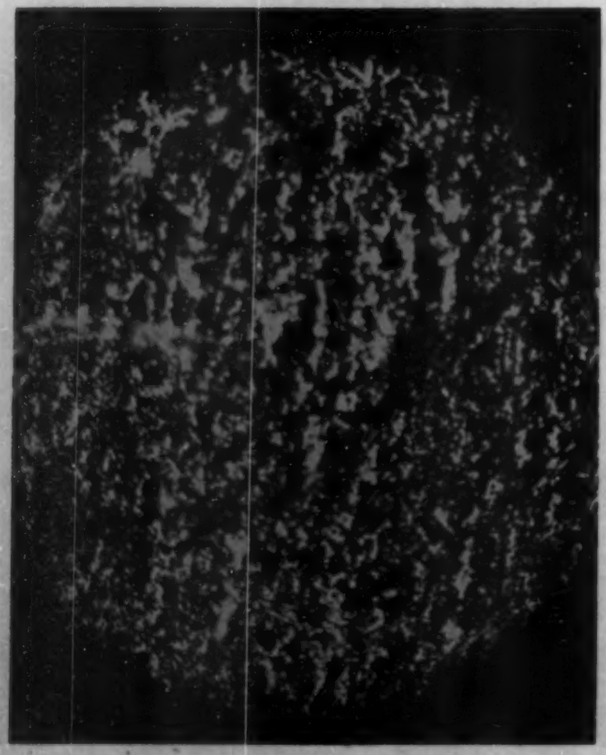
TABLE I

Maximum buffing wheel speeds for plastic products (revolutions per minute)

Diameter of buff	Phenol formaldehyde Molded and Laminated	Phenol formaldehyde Cast	Urea formaldehyde Molded	Cellulose derivative
6 in.	6000	5000	5000	3000
8 "	4500	3750	3750	2200
10 "	3500	3000	3000	1750
12 "	3000	2500	2500	1500
14 "	2600	2150	2150	1300
16 "	2300	1850	1850	1150

Typical dull, unfinished surface of plastic material. Magnification 250 times

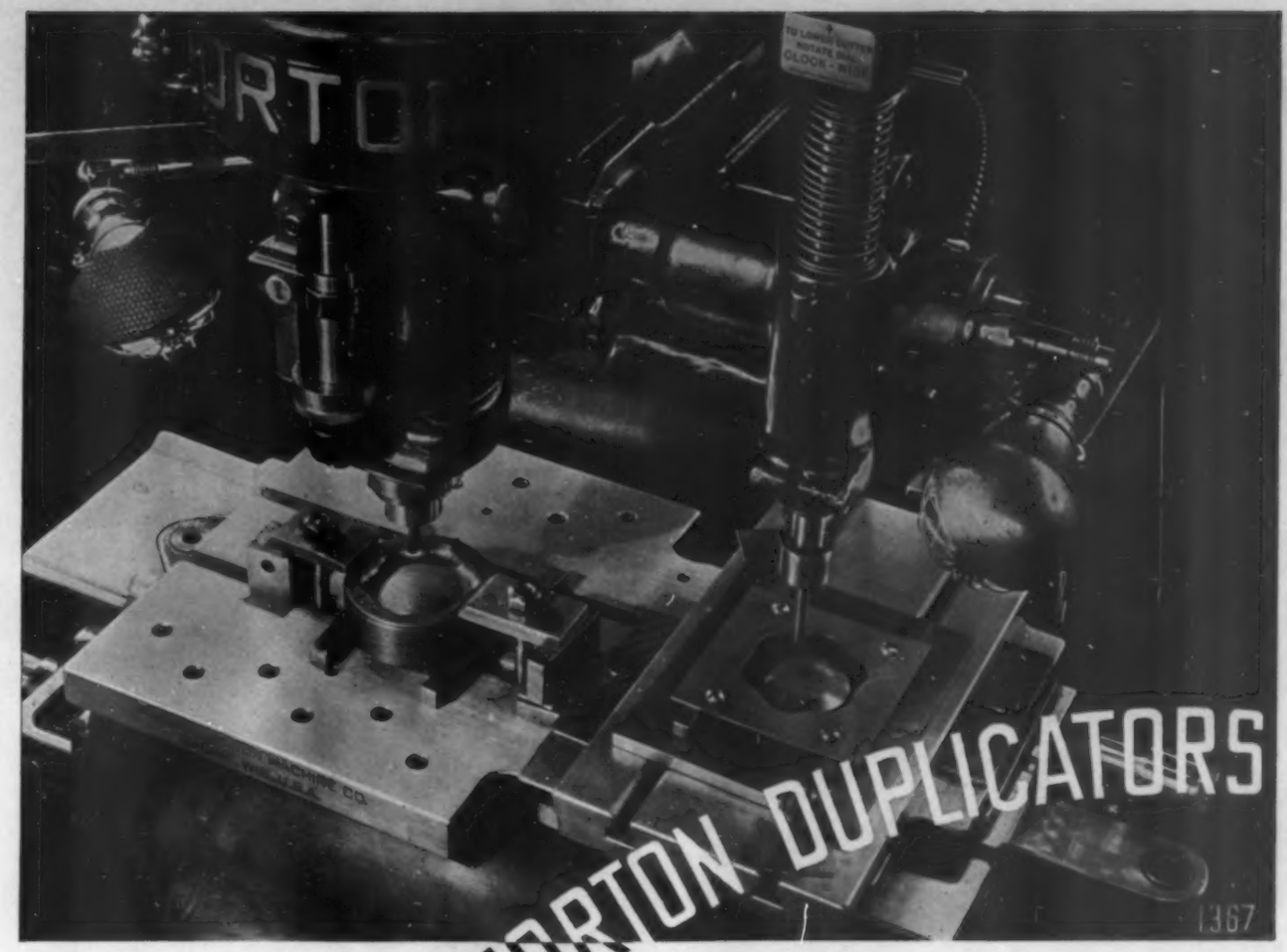
2



Physical characteristics of plastic surfaces

As one undertakes the finishing of plastic materials, he should examine closely the physical characteristics of the surface which must be finished. Unlike metals and metal finishing, there are no hard, porous oxide layers to cut through; though there are rough and uneven surfaces at times. Rough machining of bar and sheet stock of cast phenolics leaves rough and uneven surfaces. This type of surface requires the longest finishing operations. A typical dull sanded, plastic surface is illustrated in Figs. 2 and 3 at two different degrees of magnification. The referenced photomicrographs are studies of light and dark areas, indicative of the heterogeneous nature of the surface. The photomicrograph at 500 magnifications affords a better interpretation. Badly pitted areas are observed, a condition which arises during the cutting action. Large chunks of plastic material were torn from the surface, leaving numerous mounds and depressions. The illustrations are of a thermosetting resin. It is evident from the photomicrograph why dull, sanded surfaces will absorb more water. The total effective surface area which absorbs water is not a two-dimensional measurement (as for smooth and glossy surfaces), but a three-dimensional measurement taking into account the hills and the valleys.

The surface condition of the mold, as is well known, plays an important part in determining the finish of the molded object. Steel plates are used to produce a *dull-finish*, and brush finished stainless steel plates produce what is known as *satin-finish*. For a *high luster finish*, highly polished copper, nickel silver, stainless steel, and chromium plates are used. The cost of the highly polished molds runs considerably higher than the others, as the polishing requires a careful hand operation. It may prove more economical in some cases to invest in a less expensive mold and a more elaborate finishing procedure. The finishing, either by tumbling or buffing wheels, is required to remove surface defects on the plastic objects, which arise sometimes out of the molding operations. The



EXAMPLE No. 1367 — Bottom plate for glass mold. Formerly routed out by hand on milling machine in 30 minutes. Produced within .002" of size with 8½D Duplicator in 7 minutes in chilled cast iron with one roughing cut. The illustrations show plate just as it left Duplicator and plate and master set up on Duplicator. This master design is recommended for small lots or temporary use. The flat brass template limits the lateral movement of the tracer, and the curved plate beneath guides the vertical movement. Many combinations can thus be obtained.

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If your problem is production of small dies and molds for plastics, glass, rubber, die castings, drop forgings, etc. you can stop scouring the country for tool makers. You will be a lot better off both now and in the future to install a Gorton Duplicator and make use of the semi-skilled mechanics that you can more readily lay hands on.

The cost of Gorton Duplicators is low as duplicators run. They are simple to operate and you can train in a day any reasonably intelligent mechanic to produce accurate work. Faster too than the skilled die maker by ordinary methods.

Look over the job shown here. A Gorton Duplicator (view looking down on work table showing milling cutter spindle on the work at left and tracer point on the master at right) is reproducing the bottom plate for a glass bottle mold.

This is one of the simpler jobs. Watch our ads for some of the more complicated jobs done just as easily. Send for descriptive bulletins and names of manufacturers who have been using Gorton Duplicators for one to three years.

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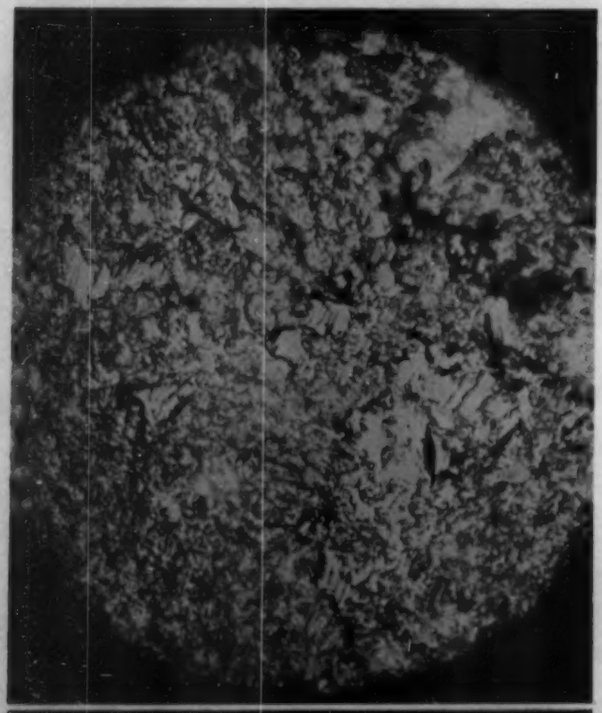
molded pieces have a fin or flash upon their surface, which appears at the line of demarkation of the closing of the two molding surfaces. The fin may be removed by file or by a fine abrasive polishing wheel, and then lightly buffed. The presence of staining, blistering or heat marks upon the molded surface (which are well known to custom-molders), requires finishing to restore the surface to the proper gloss. This is particularly essential for the thermosetting resins, which cannot be melted down and used again. Consequently, it is uneconomical to reject a molded object, when there are finishing operations to restore a molding defect. In the great majority of cases, the aim of the finishing process is to form a thin, clear, resinous layer on the surface of the object, which, unmarred by grease or blemishes represents the smooth, glossy surface that lends to the object its attractive appearance.

Below—Typical dull, unfinished surface of plastic material. Magnification 500 times. At bottom—Typical scars on plastic surface. Magnification 250 times



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4

Characteristics of abrasives

A brief review of abrasives will lend meaning to the discussion on the specific methods of finishing plastics and the materials required. Whether it is by tumbling or by a revolving buff, the action of the abrasive upon the plastic surface is the same in each case. A much longer period of time is required for the tumbling operation, but a large number of pieces may be accommodated at the same time.

Broadly speaking, plastic finishing operations and abrasives may be divided into the following groups, listed in Table II.

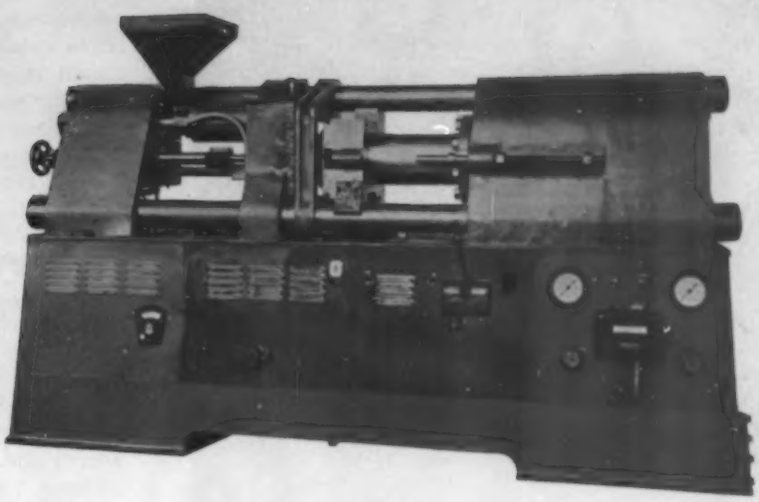
TABLE II

Abrasives in finishing plastics

Nature of operation	Smallest mesh size of particles	Relative particle size	Typical abrasives
Sanding	50 -100	Coarse	Pumice (coarse grd.) Emery.
Ashing	80 -150	Medium	Pumice (Medium grd.) Silica.
Buffing	150-300	Fine	Rouge, Tripoli, Aluminum Oxide, Chalk.
Coloring	300- up	Very fine	XXXX, Vienna Lime, Rottenstone.

Abrasives are provided usually in powder form for tumbling operations, and in brick form for the medium to fine grades for the buff finish. As will be noticed in the above table, there is an over-lapping of operations, such that the four operations are seldom used upon one article. In other words, some sanding abrasives may fall into the ashing class, and supplant the ashing operation. The abrasives are available within the indicated ranges, and it is possible to have a wide selection of materials. A fine buffing abrasive can be used to complete finishing operations giving a surface with a smooth clean appearance, though not with the high gloss obtainable by coloring. The requirements of the specific task will determine the most economical and most satisfactory operations. Attention should be invited to the fact that the application of abrasives to plastic finishing is far from standard. There are so many variable factors entering into the characteristics of abrasives that no exact solution exists at present. Thus, for example, the friability of an abrasive, which is its ability to resist crushing and breaking down into smaller particles during abrasion, should be considered. It should be remembered that the harder the particles, the more rapidly does abrasiveness increase with particle size. Absorption of moisture and oil, fracture appearance, density, and porosity characteristics are to be considered likewise.

When the abrasive is furnished in brick form, the binder composition should be taken into account. If a particular composition leaves the plastic object in need of a thorough cleaning after the finishing, it may prove wise to eliminate the cleaning operation by



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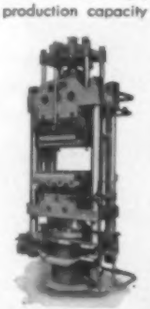
The swing to plastics for volume manufacture of innumerable parts has given new impetus to the development of faster, more efficient steam platen presses . . . A good example is the Southwark semi-automatic molding press illustrated. This press has the production capacity of 4,500 molded parts per hour.

●



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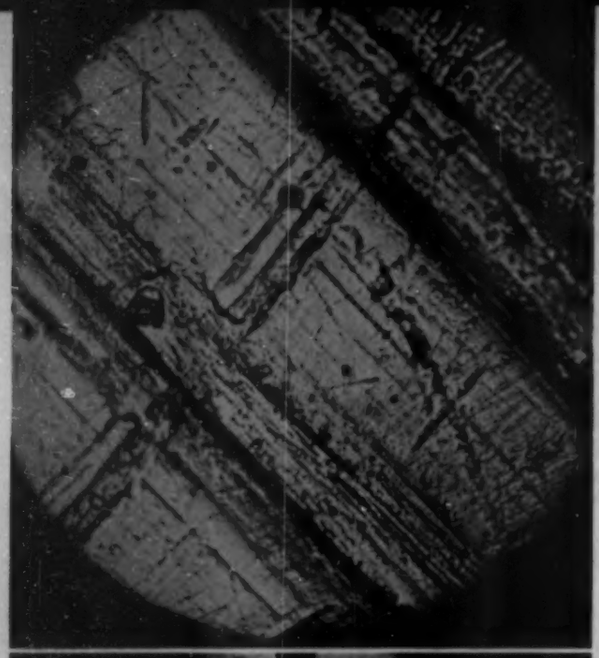

5

6

Top—Longitudinal grooves on rod of plastic material. Magnification 250 times. Above—Coarse abrasive on plastic surface. Magnification 250 times

using a composition which will leave the work clean. However, the very compositions which cause the smudged surface are usually necessary to good finishing because they may: 1. Act as a lubricant, 2. Cause the abrasive to adhere to the buff, and 3. Give a high melting point to the compound and prevent softening.

Applications of abrasives to plastic surfaces

For the main part, the characteristics of abrasives have been determined for metal finishing conditions. These characteristics are altered in the application to plastics. As the hardness of a plastic surface is less than a metal surface, an improved performance is exhibited by the abrasive. The crushing of the particles is less likely to occur during the finishing operations, and consequently a greater weight may be given to Table II. As a contrast, a metal finisher would claim that the classification of an abrasive under a specific particle size does not mean much, as the abrasive soon breaks down into smaller particles. This is less apt to occur during plastic finishing.

Condition of the surface to be finished will be the deciding factor in the selection of finishing operations. Thus a rough machined, badly scarred, or grooved surface will require an ashing or sanding operation to begin with. If this operation was attempted upon a plastic surface only slightly marred or bruised, the operations would be prolonged unnecessarily. In the latter case, a buffing operation followed by a coloring operation will sometimes restore the surface to its proper degree of finish. The photomicrographs in Figs. 4 and 5 show typical imperfections upon plastic surfaces. In particular, the die marks upon the plastic rod should be noted in Fig. 5. In Fig. 6, pumice of about 100 mesh size is shown upon the surface of the material to be ashed. Particles of this size are most effective in cutting down the imperfections shown on Figs. 4 and 5. Of course, smaller particles would eventually remove the imperfections, but at a much slower rate.

In Figs. 7 and 8, mild surface imperfections are revealed, and rather than harshly scar the surface with a coarse abrasive, a fine abrasive, such as illustrated in Fig. 9, is used. The tracks left by the abrasive become smaller and smaller as finer particles are used, until finally, during the coloring operation, there is a viscous flow of surface molecules which fills all cracks and crevices to leave a smooth, unblemished, high gloss surface. During the coloring operation, sometimes no abrasives are used, and a soft flannel disc

Below—Inroads on scarred plastic surface by mild abrasive surface of laminated plastic. Magnification 250 times

7

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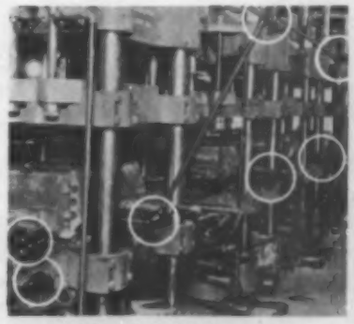
BARCO Swivel Joints are profit protection on this 800-ton steam platen press.

On this watch case bicycle tire mold BARCO swivel joints remain leakproof under alternating steam and cold water.



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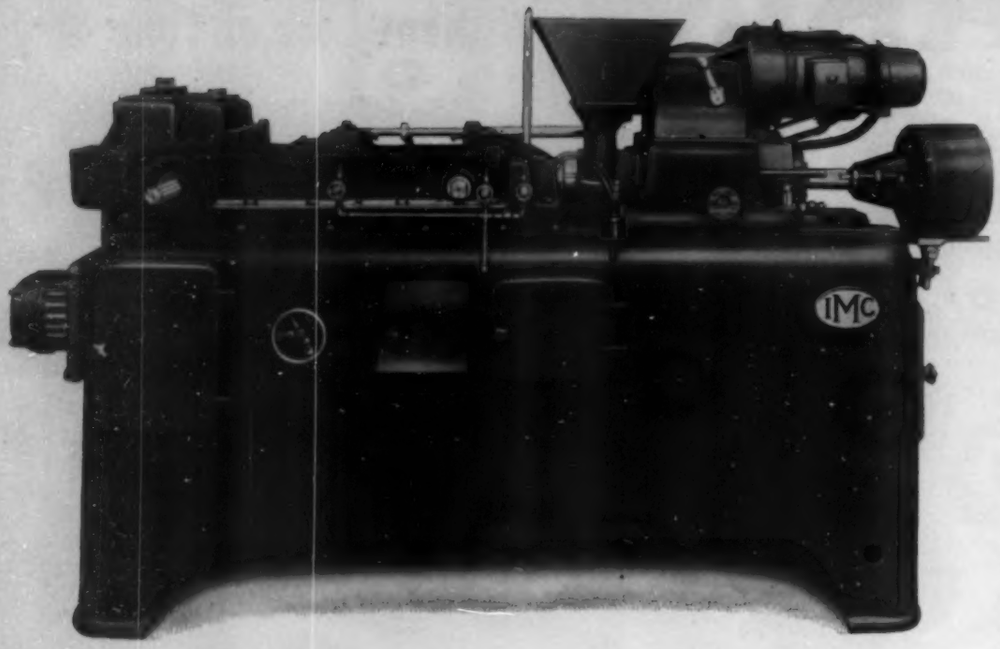
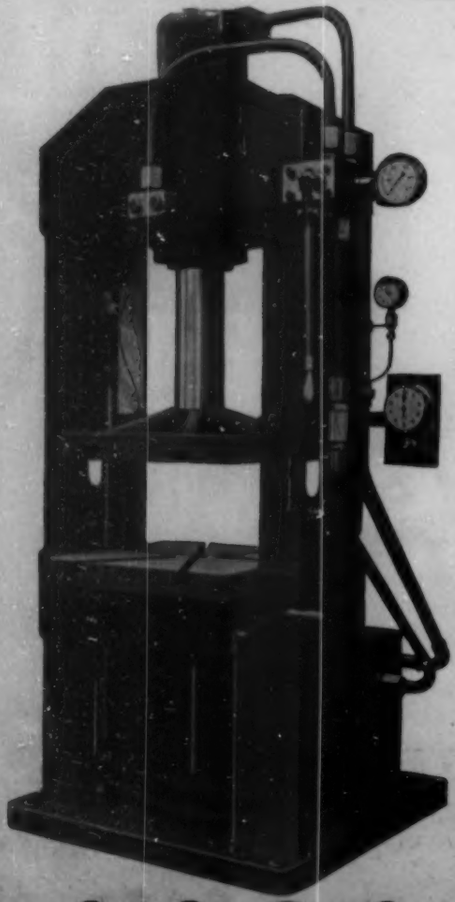


A fully automatic molding machine that predetermines production and makes it independent of the attention or skill of the operator. Two electric time switches completely control the cycle of operation. One time switch precisely regulates the interval for plasticising the new volume of material introduced into the cylinder at each stroke. This automatic control insures uniform heating of the material from the outside and inside of the mass in the cylinder.



HIGH SPEED HYDRAULIC PRESSES FOR MOLDING PLASTIC MATERIALS

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The other time switch governs the interval during which pressure is maintained on the material solidifying in the mold, thus preventing sagging or sinking of the article from contraction when cooling. Finishing operations, such as polishing, are eliminated. Only the gate need be removed. Machine is easily and accurately set. Power consumption is small and there is no loss of material. Manufacturing cost is low because an automatic high rate of production of a uniform product is constantly maintained.

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suffices to create the viscous flow which leaves a high gloss, and at the same time, a clean plastic surface.

Tumbling cast phenol formaldehyde articles

Roughing operation: This operation will remove all tool marks and scratches from the article. Into a hexagonal or octagonal tumbling barrel, about 30 in. in diameter, place the articles to be finished. Add coarse pumice, and wooden shoe pegs in a 1 to 10 proportion. Tumble at 40 to 50 r.p.m., until a smooth surface is obtained (usually 18 to 24 hours). Resinous scrap and vegetable ivory have been added at times to increase the friction.

Cleaning: After the roughing, the articles should be washed thoroughly to remove all traces of the pumice. Tumbling with moist hardwood sawdust in a separate barrel often expedites operations. When the articles are cleaned, they are ready for the next operation.

Polishing operations: The finishing barrel should be of a good grade of hardwood and lined with heavy felt. The articles are then tumbled in a special wax composition of carnauba and beeswax, with wax coated shoe pegs, for 24 to 25 hours. The articles will be finished with a high gloss.

The time for the last tumbling operation may be considerably lessened if prior to the cleaning operation the articles are tumbled in a mixture of a buffing abrasive (chalk or tripoli), which will eliminate the deep scratches left by the pumice. This intermediary step is preferred by some manufacturers.

8

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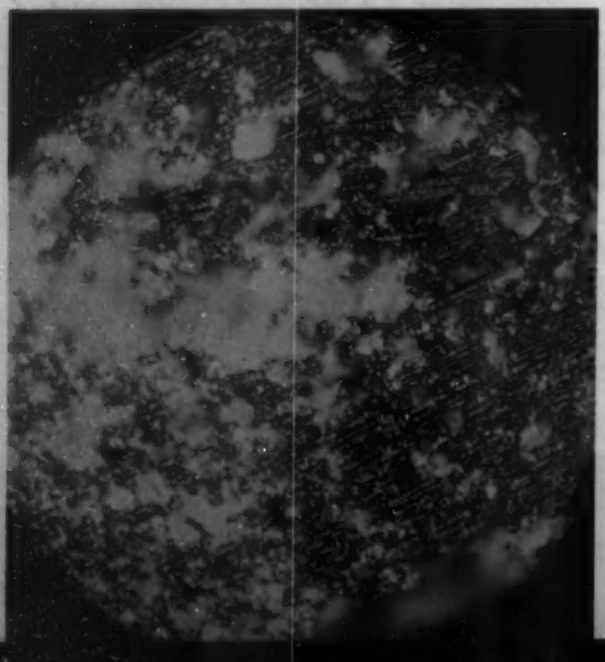

Above—Polishing ridges on plastic surface about disappeared. Magnification 250 times. Below—Powdered rottenstone on plastic surface. Magnification 250 times

Tumbling molded articles

For molded phenol formaldehyde and urea formaldehyde articles, the tumbling operations are simplified. The flash is removed by tumbling the articles with wooden pegs as buffers. To restore the high gloss, the parts may be tumbled with wax covered pegs. It must be remembered that the finishing of molded articles is subject to the limitations already brought out, regarding the condition of the surface.

In all of tumbling operations, there are equivalent cloth wheel operations which are designed for the large and more complicated articles. It must be emphasized once again, that the condition of the surface should be examined and the proper course of action be decided, tapering off with the degree of luster desired. A large assortment of abrasives is available to achieve any degree of finish.

Dipping procedures

To complete the description of finishing plastic materials, attention is invited to the dipping processes which have been used on thermoplastic resinous substances in the finishing operations. The dipping is analogous to the acid-dip for metals, except that in the case of a resinous compound, acetone liquid or vapor is used. The effect of such a procedure is to soften the surface, preparatory to the final coloring operation. Extreme care must be taken in dipping to avoid leaving the articles immersed too long, otherwise distortion will occur.

A selected list of references is given below for the benefit of the reader who desires to investigate further the methods and materials of finishing operations.

Polishing and buffing wheels

1. J. J. Manderscheld—"Facts Relative To Polishing Wheel Industry," Metal Industry, vol. 27, no. 1, p. 25, Jan. 1929.
2. F. B. Jacobs—"Manufacture of Cloth Polishing and Buffing Wheels," Platers' Guide, vol. 32, no. 3, p. 13-18, March, 1936.

Finishing Technique

3. B. H. Divine—"Pre-requisites of Successful Polishing," Mech. Engr., vol. 49, no. 9, p. 975, Sept., 1927.
4. L. Reis—"Probleme des Glaspolieren," Z. F. Verdeutcher Ingenieure, vol. 76, no. 8, p. 181, Feb. 20, 1932.
5. "Buffing and Polishing Methods," Lea Manufacturing Co., 96 pages, Waterbury, Conn., 1935.

Abrasives

6. M. L. Smith—"Influence of Particle Size, Shape, Aggregation and Hardness on the Abrasiveness of Fine Powders"—Jl. Soc. Chem. Ind., vol. 54, no. 34, p. 785, Aug. 23, 1935.
7. R. S. Leather—"Abrasives Used in Polishing and Buffing of Metals," Platers' Guide, vol. 32, April, May, June, 1936 (contains correlated abstract).
8. "Making Better Metal Polishes"—Chemical Industries, vol. 38, p. 283, March, 1936.

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Flexible metal tubing—its use in molding

BY JOHN L. VAILL*

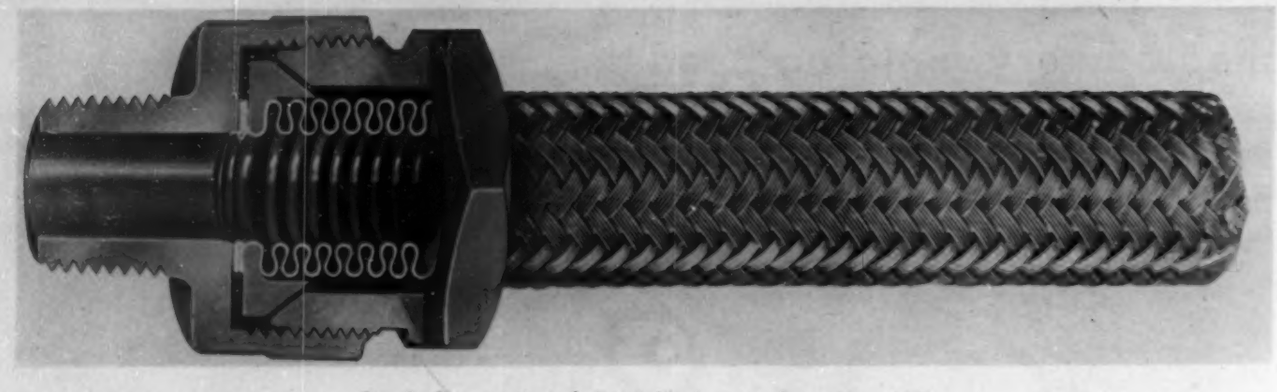


Fig. 5. Cross section of detachable heat-proof coupling which remains tight under the alternate flow of cold water and steam

With the many types of flexible connections available today for conveying steam to and from the dies and platens of hydraulic presses, either constantly or alternately with cold water, plastics molders may well wonder which type or style they should adopt. That flexible connection which completely satisfies the following requirements may be designated as *BEST* for the purpose. The most important consideration is long continuous service without leaks or attention of any kind. Next in order follow: a low first cost, a low installation cost, and finally, the occupancy of as little space near a press as possible.

A few years ago, the only type of flexible metal tubing available was made from strip metal spirally wound with a packing in the joints. This style of flexible metal tubing, while it gives remarkable results in some classes of work, proved unsatisfactory for this particular service. The answer, however, soon came in the development of a new packless, pressure-tight and leakproof style of flexible metal tubing. Just as plastics molders have made a great deal of progress in the past few years in improving their processes and products, so have the manufacturers in the flexible metal hose and tubing industry.

Formerly seamless flexible tubing was only made from drawn seamless brass tubes composed of 80-85 per cent copper and 15-20 per cent zinc. Actual installations and laboratory research proved that these high zinc alloys under stress had insufficient resistance against steam corrosion. Laboratory research then soon found that bronzes of 98¾ per cent and 95 per cent copper and 1¼ per cent and 5 per cent tin respectively, under stress, offered a maximum resistance against steam corrosion, but the use of bronze tubing with comparatively thin walls was practically prohibited because of cost. New manufacturing methods and standards, however, have made thinner gauge bronze tubes procurable, and the seamless flexible tubing now made from relatively thin gauge tubes bends to a smaller diameter, is lighter in weight and has a longer flexing life which means greater economy.

Another feature, aside from the alloy of the new bronze tubing, is the gauge of the metal. Seamless flexible tubing of comparatively thin gauge is lighter in weight, bends to a smaller diameter, and has a longer flexing life. New manufacturing methods have made possible thinner gauge tubes, but not too thin to be affected by the passage of steam and water.

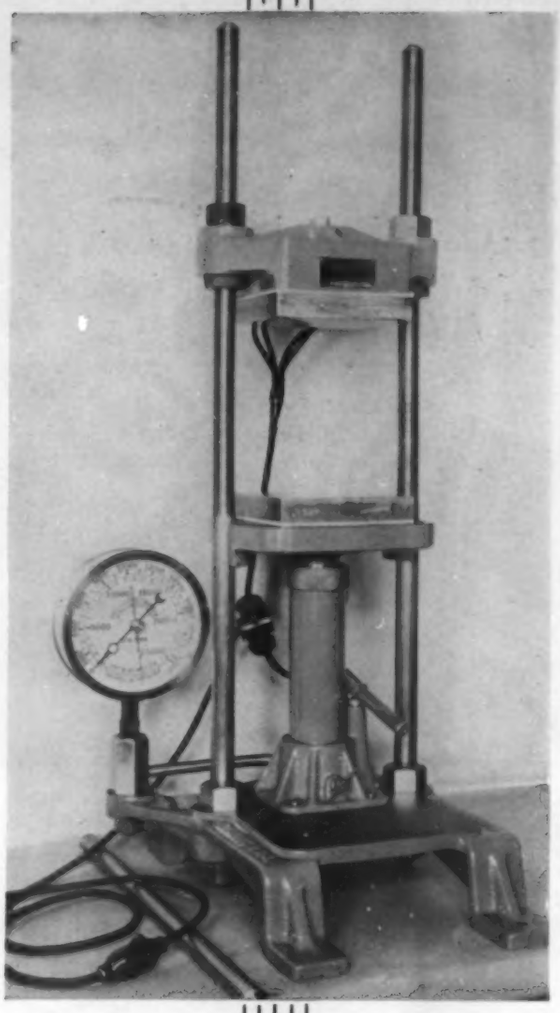
A sounder tube is now used, and metallurgists have also found that the fewer anneals a tube undergoes in reducing it from a heavy gauge to a light gauge, the freer that tube will be from any defects. A tube finished to the desired gauge is passed through a continuous electric annealing furnace, the temperature of which is accurately and automatically controlled. This assures a uniformly annealed tube. Deep corrugations, either helical or annular are machined into this tube and impart necessary flexibility. An outside jacket of bronze wire braiding is then applied over the tubing to give added resistance to internal pressures and prevent elongation.

The most important point for the molder to consider after securing this improved flexible tubing is the installation. Correct installation is essential if the longest possible service is to be obtained. Fig. 1 shows the front view representing a typical and proper installation on a hydraulic press where steam and cold water are circulated alternately through the dies.

The flexible tubing assembly should be installed in a free loop of large enough bending diameter to prevent the building up of localized flexing stresses and also long enough to allow for short straight sections just beyond each coupling, whether the press is open or closed. Should the flexible tubing ultimately leak, the failure, in a majority of cases, will occur just back of the coupling and will be because of excessive bending stresses built up where the flexing section enters the rigid fitting. Straight sections act as a neutral zone between the bending part of the tubing and the coupling. Best practice calls for locating the stationary coupling midway between the open and closed positions of the movable coupling on any molding press.

The sketch and table in Fig. 2 are to aid the molder

* Superintendent, American Metal Hose Branch, The American Brass Company



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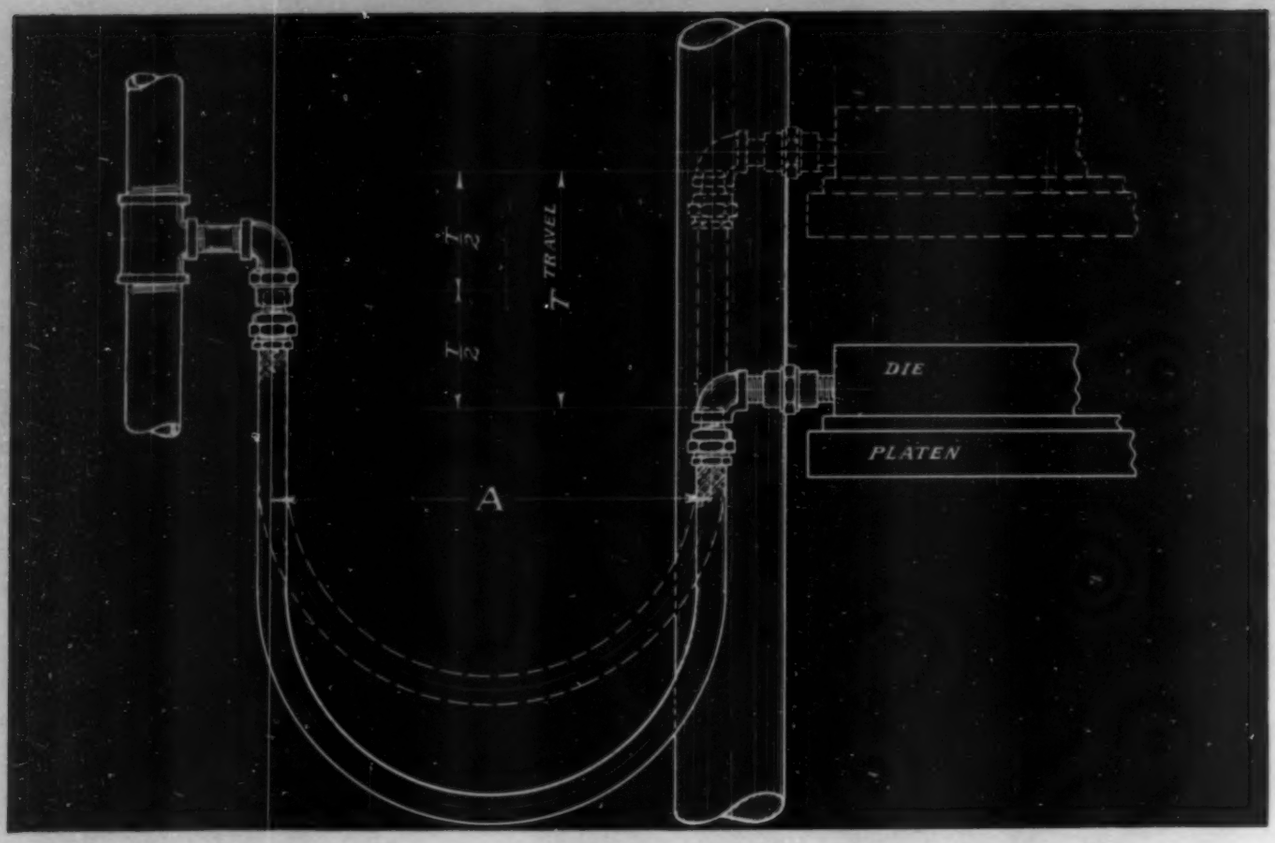

Fig. 2. Chart for determining minimum overall length of flexible tubing required for any installation. See table below

in determining the minimum overall length of flexible tubing required for any installation, and the minimum recommended diameter to which the flexible tubing should be bent. Should larger bending diameters be required, the formula shown under the table should be applied. "T" designates the amount of travel, while "A" represents the smallest diameter to which the flexible tubing should be bent. "B" is a factor allowing for the length of the coupling and straight sections previously mentioned. Many users order the original lengths 6 in. to 12 in. longer than necessary, and if the tubing ultimately wears out back of a coupling, simply take out the whole assembly and repair it in their own plants as described below. (See Fig. 5.)

I.D. of Tubing	B	Min. A	Min. Overall Length
¼ in.	10 in.	7 in.	21 in. + ½ T
⅜ in.	10 in.	10 in.	26 in. + ½ T
½ in.	12 in.	14 in.	34 in. + ½ T
¾ in.	14 in.	19 in.	44 in. + ½ T
1 in.	16 in.	22 in.	51 in. + ½ T

Overall Length = B + 1.57 A + ½ T

Fig. 1. Correct installation of flexible metal tubing on hydraulic press

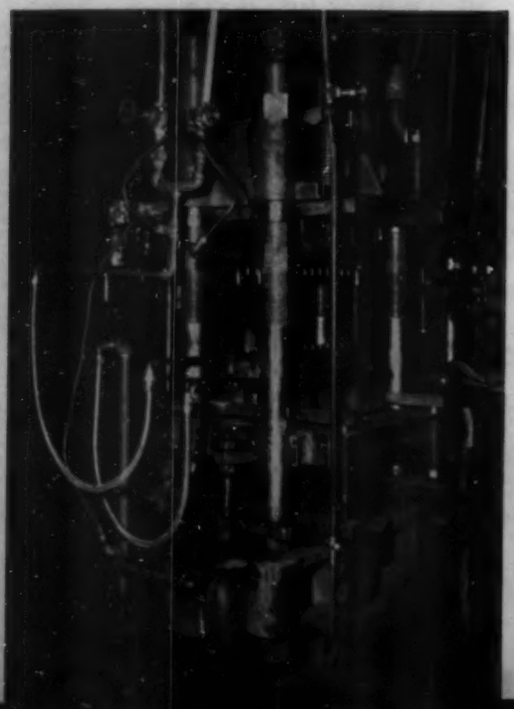

Fig. 3 shows a side view of Fig. 1. The flexible tubing during all movement is in one common vertical plane. This is accomplished by facing the elbows down and properly making up the unions without twisting the tubing. Best results will be obtained by following this practice.

Fig. 5 illustrates, in cross section, a simple and compact detachable male coupling which is heatproof and remains tight under the alternate flow of cold water and steam. This type of coupling can also be obtained in the union form. There are three parts to this coupling; the male top part, the split ring and the end nut. Only a few standard tools are required in attaching this type of coupling to seamless corrugated tubing; namely, a vise, wrench, hack saw, wire shears, and some flat blunt-edged tool. If, for any reason, the seamless tubing should ultimately fail back of one coupling, it is a simple matter requiring

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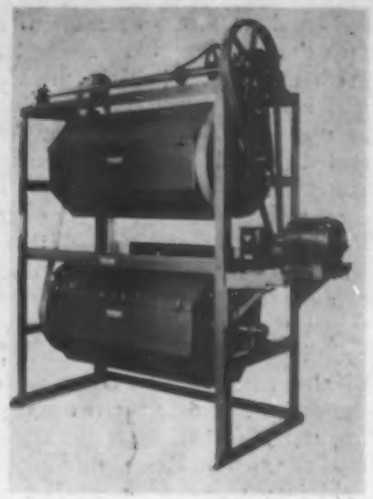

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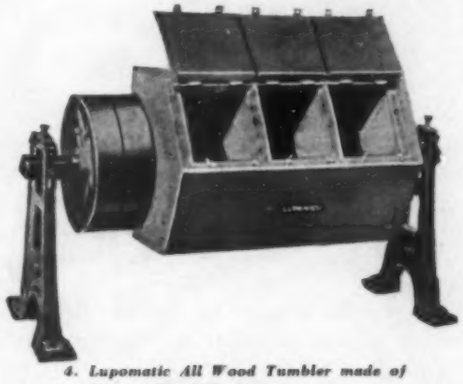

4. Lupomatic All Wood Tumbler made of Selected Hard Maple.

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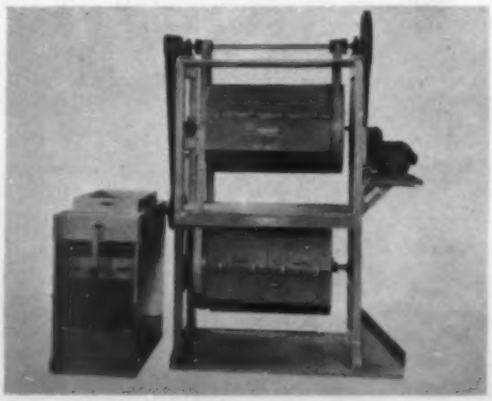

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only a short time to remove it from the press, reattach the coupling and put the length back in service. With the tubing held in the vise, the worn-out section is cut off; then the flat blunt-edged tool is used in opening up spaces between the first and second and the third and fourth corrugations. Another saw cut is then necessary to remove the first convolution, care being exercised not to multilate the side of the second corrugation, which is to act as the seat. After the end nut has been slipped over the braided tubing, the split ring is inserted into the space between the third and fourth corrugations. The wire braiding is then pushed up over the tapered section of the ring and trimmed with wire shears; then the end nut and top part are made up together, locking the wire braiding and seating the last two corrugations against the male top part, the end nut being held in a vise during the last operation. Because of the steep taper on the split ring, absolute tightness can be obtained in locking the wire braiding and seating the seamless tubing. This seat, which is all-metal, is impervious to the temperature changes and pressures of steam and cold water. This coupling is popular because of its simplicity and strength.

Should a length of tubing, for any reason, be removed from the press, it should be reinstalled so that the direction of the bend in the loop is the same as the original installation. Actual experience has shown that a much more extended service will be obtained from the tubing if this procedure is followed. Actually flexing the tubing before replacing it on the press will reveal the correct direction of the previous bend.

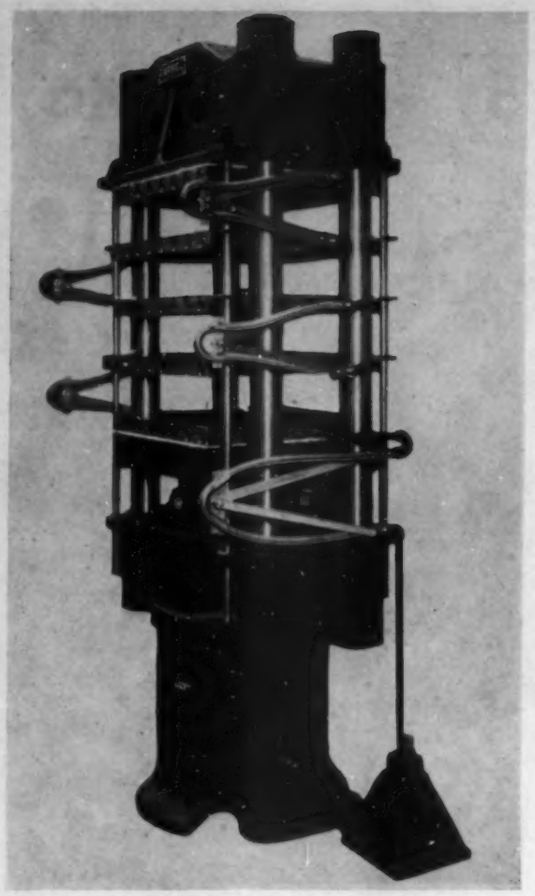
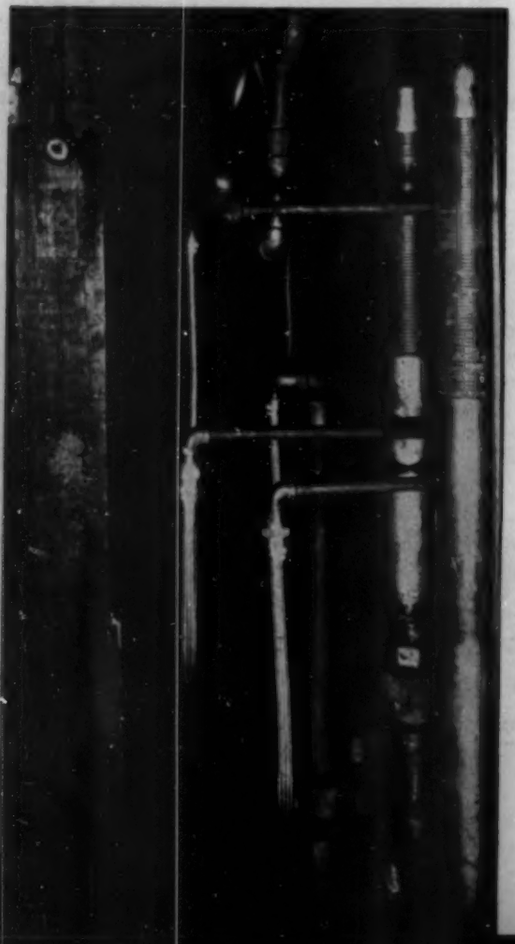


Fig. 4. Illustrating the installation of seamless flexible tubing with a mechanical support

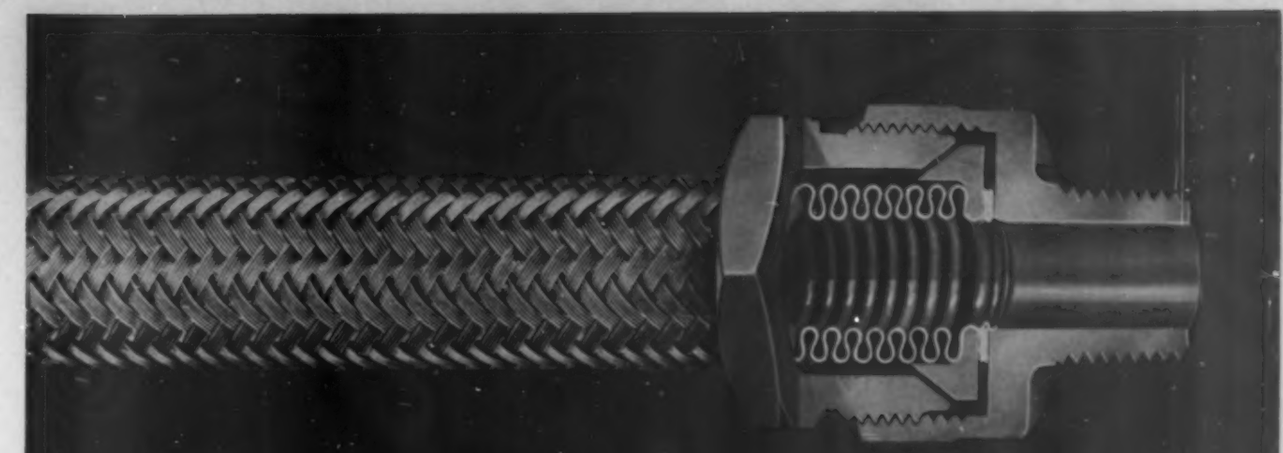
Fig. 3. Side view of Fig. 1. The flexible tubing during all movement is in one common vertical plane



In order to reduce radiation to a minimum, assemblies are very often made up with an asbestos jacket or covering. In other cases where there is a danger of mechanical abrasion of the wire braiding, an overall bronze armor of flexible metal tubing is supplied for the proper protection of the braiding and the inner tubing.

Fig. 4 illustrates the installation of seamless flexible tubing with a mechanical support. The function of this supporting mechanism is to keep the assembly in a self-draining position at all times and to control the flexing of the tubing. The results are the speeding up of heating and cooling of dies by the elimination of any possible water pockets, and longer life of the tubing through distributed flexing. This type of assembly is practical for all uses where steam circulates through platens or through dies that are infrequently changed on the press.

There remains yet for mention the estimated life of seamless flexible tubing assemblies. Since the many improvements above noted have been made within the past few years, and since failures of the tubing have been so few and so isolated, it is difficult to give any precise data in this regard. Laboratory tests have demonstrated, however, and actual installations are proving that, with correct installation, this new tubing has increased from three to four times the service expectancy of flexible press connections.



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The buffing wheel and tumbling barrel

BY RUDOLPH R. SIEBERT*

Early in the plastic industry the common practice used for the finishing of pyroxylin, vulcanized rubber, and other molded articles was to first use an ashing wheel, which was usually made from cornhusks, carpets, and other materials suited for the particular product. With these wheels a combination of ashes and pumice with water was used as an abrasive. For the removal of tool and other processing marks this is a preparatory operation. After this the articles are washed, dried, and then put through a tripoli polishing operation, which is performed with a cotton buff wheel, to which a compound of wax and flour tripoli is applied and which establishes a smooth, semi-polished surface. The next and final operation is performed with a soft buffing wheel and is usually called *coloring* by the trade.

It can be readily understood that in hand buffing where the articles are polished piece by piece that not only is the labor cost high, but also the cost of the several types of wheels used, which wear very rapidly, also the buffing compounds used in the operation are quite costly for many articles. Many types of semi and semi-automatic buffing machines were developed and in some industries are in use today, however, here again the cost of finishing is rather high on some particular types of products. For molded phenolic and urea clock-cases and articles of like type and size, the use of the tripoli buff wheel is still essential. Articles of this kind cannot be handled economically and with safety in a tumbling barrel, so it can be stated here that there is still a field for the buff wheel as well as for the tumbling barrel.

Tumbling barrels have been in use in the last 60 to 65 years in various industries and especially in the jewelry and small metal articles industries, where they are used not only for the polishing of brass and copper, but also for the precious metals, and in this field were developed for low cost and efficient work as long as 30 or 40 years ago. For the polishing of vegetable ivory buttons the tumbling barrel was used as early as 1887 and until 10 to 12 years ago tumbling barrels and processes for finishing vegetable ivory buttons had their greatest development. With the advent of syn-

* Manufacturer of equipment for barrel finishing of non-metallic materials.

Octagonal tumbling barrel in which small plastic parts are frequently finished, saving the more costly operation of hand buffing. (Photos, courtesy of the Author)

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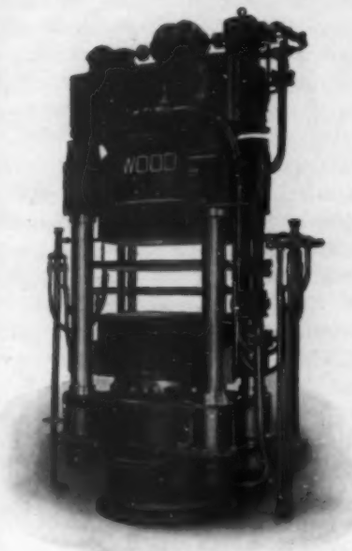

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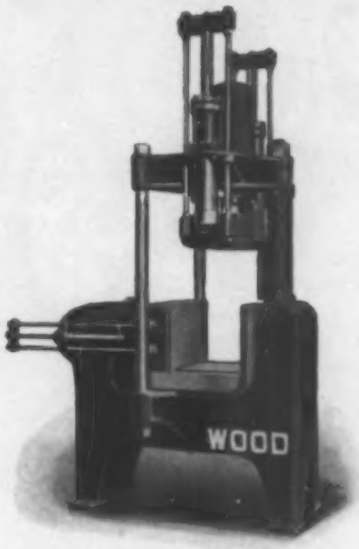

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CATALIN

Above—The buffing wheel is still employed for finishing larger moldings which would not be practical to include in the tumbling barrel. Below—A complete installation of tumbling barrels in a modern molding plant

thetic materials, beginning with the fabricating of pyroxylin into various articles of adornment and toilet purposes, wet tumbling came into use in some plants. This was usually accomplished by the use of pumice and water, sand and water, small pebbles and water, and hundreds of other experiments were also tried. The tumbling of pyroxylin with pumice and water, as practiced in the early days and up until recent years, was rather a dirty and sloppy operation, in many respects parallel to the use of the ashing wheel. After the wet pumice operation it was necessary to wash the articles and dry them before using tripoli and coloring buff wheels on the articles. The net result of this practice was that it eliminated the wheel ashing operations, but the tripoli and soft wheel buffing was still essential.

Some twelve years ago the dry tumbling process was developed, which not only performed the operation of ashing, but completely finished articles from the tumbling barrel ready for assembling or shipping and at a surprisingly low cost of production. The piece by piece handling of the buff operator was eliminated and the articles were handled in a much larger mass and finished with a distinct uniformity, which is not possible to obtain by hand buffing methods. It is estimated that today in 70 per cent of the plants that are manufacturing articles from synthetic materials 80 per cent of their production is finished by the barrel tumbling method.

Many types of tumbling barrels have been tried and with various liners; such as, felt, vulcanized fibre, leather, etc. The gradual development of the tumbling barrel and the process for the finishing of the various articles manufactured from synthetic materials has brought about the use of standard types of tumbling barrels. For the purpose of *cutting down* or abrasive tumbling, the barrel is made from solid steel without liners of any type. For the purpose of polishing, the barrel is made from hard maple, birch, or cypress. The type of barrel generally used is approximately from 24 inches to 30 inches in diameter and from 20 inches to 50 inches in length, octagon type, with from two to four pockets. The design, size, and number of pockets in the barrel depends entirely on the articles that are to be finished and some care must be used in selecting the right type and size.

The fillers used in the tumbling barrel to act as carriers for the abrasives and polishing materials have been of various types; such as, leather scrap, chamois skin scrap, cork, felt, celluloid scrap, vegetable ivory chips, etc. The abrasives used are quartz sands, ground glass, emery, carborundum, pumice, and ashes. Polishing materials used are tripoli, chalk, polishing oils, and wax compounds. Here again the development of the processes for finishing various synthetic materials has brought into use wood balls, wood blocks, shoe pegs, and other like materials, and the choice of abrasive and the carrier for the abrasive must be studied and applied with care depending on the design of the article, the size of the article and the material from which it is manufactured and no general rule can be laid down for any given article or material, in fact, finishing the same material and the same article in different plants presents a somewhat different problem. A plant where the tooling or the

molding is held to rigid standards one method of operating tumbling barrels will bring excellent results, whereas, a plant where the tooling and the molding is rather carelessly done a somewhat different method of polishing in the tumbling barrel must be set up.

The general practice today is to mount the barrels horizontally and of sufficient distance from the floor to permit a box to set under the barrel into which articles and tumbling materials can be emptied quickly and at one time. The speed of the barrel depends on the type of article and the material from which it is manufactured, speeds vary from 20 r.p.m. to 40 r.p.m.; i.e., phenolic castings of a size up to three inches and with delicate edges where chipping is likely to occur it is well to keep the barrel speed under 30 r.p.m.; for buttons, slides, and like articles barrel speeds of from 30 to 40 r.p.m. can be used.

It must be remembered that although the process for buffing various articles varies but slightly in their application the process for finishing the various types of materials varies considerably in their application. To illustrate: For phenolic and urea castings one operation with an approximate time of four hours only is necessary for finishing the articles. Further, tumbling barrels have been developed that will on many castings remove the die flash or fin sufficiently to avoid filing or sand-papering. In other cases it will remove the rough die flash before filing. For pyroxylin, cast resin and like materials that are tooled, several operations are necessary in the tumbling barrel to produce the final polished articles and the total time required to completely finish such an article is approximately from 18 to 26 hours depending on the quality of the tooling. This group includes cutlery handles, buttons, bracelets, novelties, and articles of this type.

For the finishing of fountain-pen barrels a much shorter process is required due to the fact that the pyroxylin tubing is trap-ground and does not require a harsh abrasive operation. In this instance the total time required for completely finishing in a tumbling barrel is from 12 to 16 hours.

For the finishing of cellulose acetates, injected molded, many of these articles can be handled on a similar basis to phenolics, however, where it is necessary to file the die flash on injected molded articles or where molding faults appear, it is necessary to handle articles made from this material in a similar manner to fountain-pen barrels and in approximately the same complete finishing time.

Considering the facts as stated, it becomes apparent that each type and kind of material and in many instances the type and kind of articles must be taken in consideration in establishing a process for the finishing of such articles in the tumbling barrel, and, therefore, the process itself and the time required will vary.

It is only fair to state that today in many lines of manufacture the buff wheel is still used to quite some extent, however, the use of the tumbling barrel is slowly but surely coming into its own as a better understanding is had of its economy of cost, mass production, and uniformity of quality produced. In fact the development, production, and sales of certain of the synthetic plastics could never have reached their present heights if the low cost mass method of barrel polishing had not been at hand.

MODERN SEMI-AUTOMATIC SIDE PLATE TYPE MOLDING PRESS

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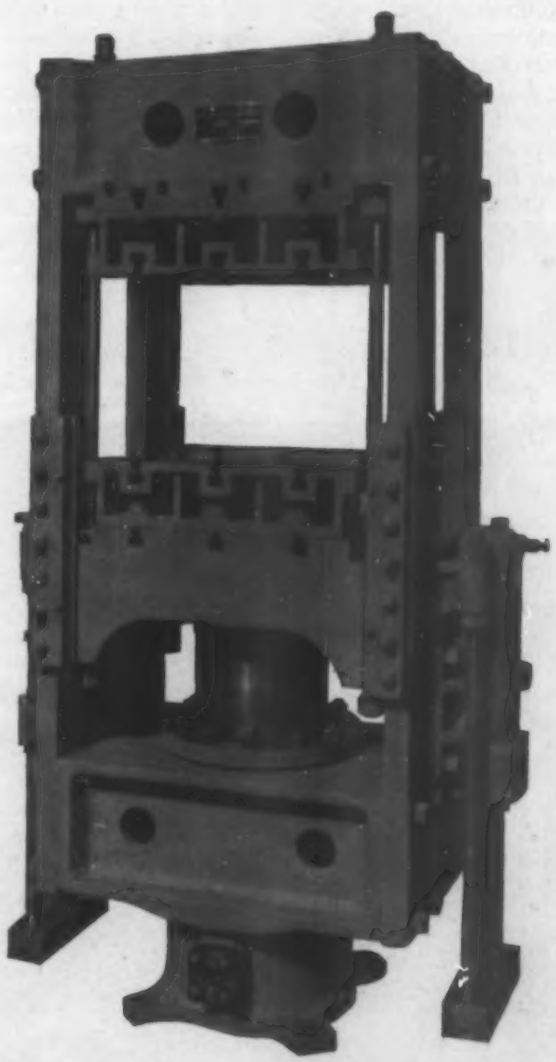


LAKE ERIE ENGINEERING CORP.

BOX 68B, KENMORE STA. BUFFALO, N. Y.

Molding plant accessories

(*Continued from page 260*) This involves a storage tank or pump and a low-pressure pump which is designed to handle relatively large quantities of water, as compared to the high-pressure system. Low-pressure water is handled by any of several types of pumps.

Press heating systems

Presses for hot-molding require a supply of heat to the molds themselves or to the platens against which they bear. Steam is most commonly used, but heating by gas or by electric resistance units is often employed. In any event, a source of heat supply is required as is a system of piping (or wiring) the steam, gas or electricity to the presses. With gas or electric heating, automatic controls to avoid excessive temperatures may be required. Steam pressure, which is often controlled automatically, determines the maximum temperature, but the mold is usually held at a somewhat lower temperature by controlling the rate of flow of the steam. This may be done with a hand valve or by automatic means. Each press is also fitted with a steam trap, designed to keep the mold free from condensed water and still prevent escape of steam directly into the drain system. As steam (or gas) is supplied to moving platens or moving portions of molds, there must be provision for such motion in the piping system. This flexibility is provided either by swing joints or by the use of flexible piping to join the main to the mold or platen.

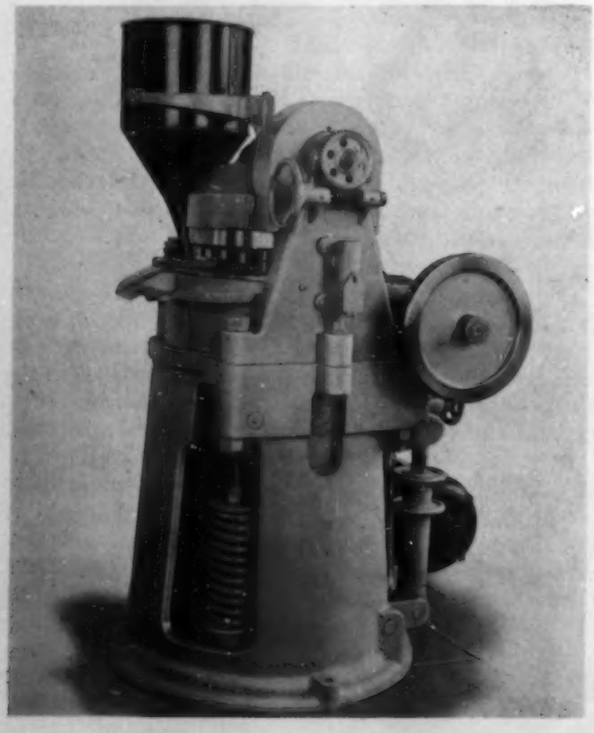
All these items constitute essential parts of molding shop equipment. Steam is often supplied from a central power or heating plant, which may be needed in any case for the building or plant in which the shop is located, but in other instances, a separate boiler, sometimes automatically fired with oil or gas, is used to advantage. Small automatic gas-fired boilers of sufficient capacity to serve a dozen or more presses are used to advantage in some instances and do away with the need for employing a fireman for constant attendance.

Compressed air systems

Although compressed air systems are simple, they are an important part of equipment even if used only to blow out molds prior to charging. Air can be used both to open and to close molds, either independently or in conjunction with hydraulic systems, and is sometimes most convenient for such operations. All that is required is a compressor of adequate capacity with suitable driving means, usually an electric motor; an air receiver; and a system of piping with suitable valves and nozzles. Blow-out nozzles are often hung by flexible rubber tubing from overhead air mains, each nozzle having its own thumb-operated, spring-closed valve to prevent leakage when the nozzle is not in use. If the air system is piped for press operation, suitable valves at the presses are employed, of course. In some instances, air has been used for ejection of small moldings from molds and it can be employed similarly for unloading special fixtures used for cleaning molded parts. Air is often employed to advantage in cleaning operations and sometimes for operating small tools in the tool room where molds are constructed. It can be employed advantageously also in hoists for handling drums of molding powder and for

Pyrometer of the portable type used in measuring temperature of molds. Made by Illinois Testing Laboratories, Inc.

Rotary type preformer which makes 350 tablets a minute. Made by F. J. Stokes Machine Co.



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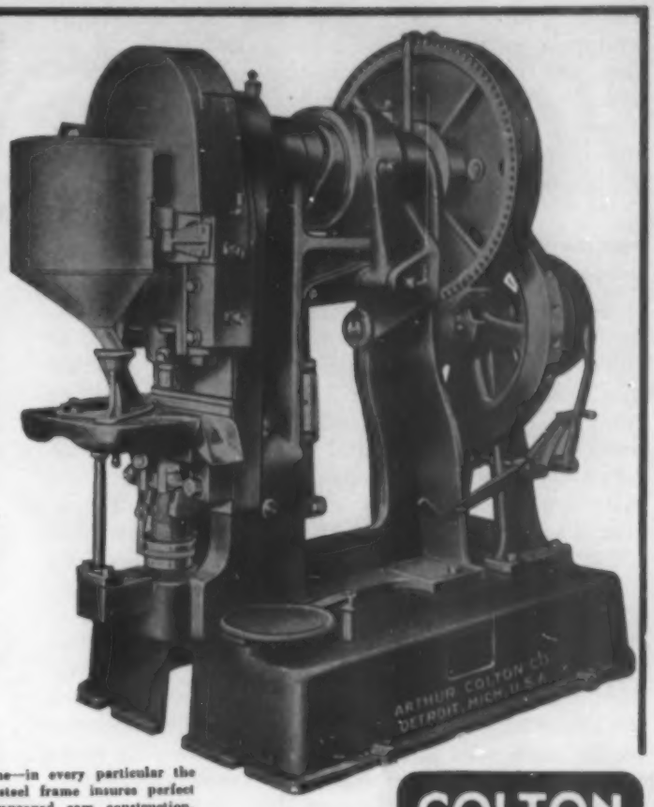

The new improved 8½ tablet machine—in every particular the finest the market has to offer. Solid steel frame insures perfect operation; improved die fasteners, improved cam construction, heavier ejecting mechanism, vanadium steel plungers—make high speeds possible without fear of breakdown or lowered quality. Makes tablets up to 3" in dia. having a fill depth up to 2⅛".

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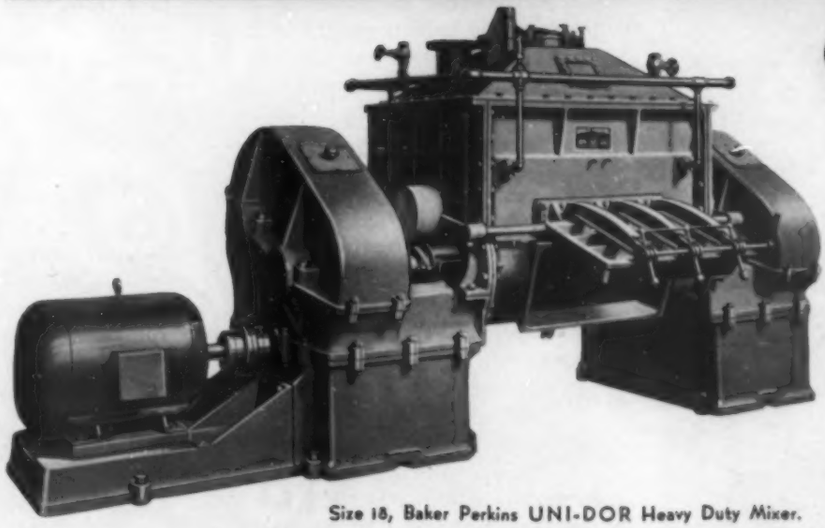
FOR HEAVY PLASTIC DOUGHS

THE B-P UNI-DOR MIXER



Size 18, Baker Perkins UNI-DOR Heavy Duty Mixer.

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- **Very Rugged Construction**
- **Gearing Totally Enclosed** and running in oil.
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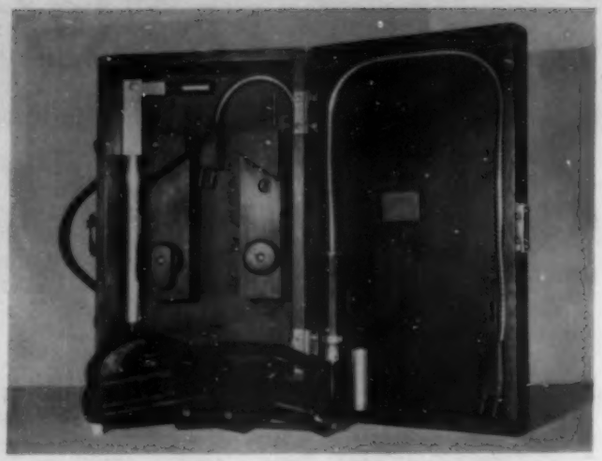
similar purposes. Air compressors are commonly equipped with automatic starting and stopping devices or, if they run continuously, with unloaders which prevent air delivery after the system is up to pressure. Pressure gages and filters for removing dust and moisture are among the minor items forming part of air systems.

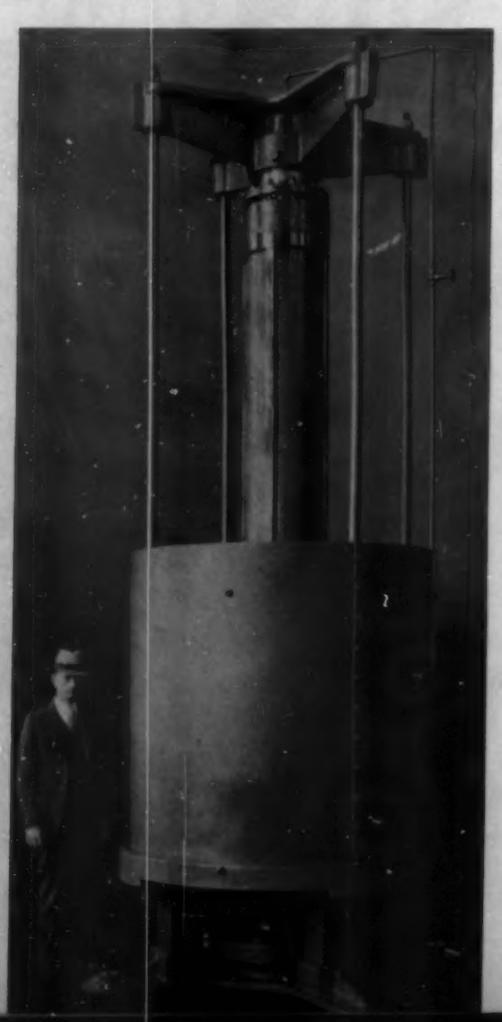
Equipment for handling molding compounds

Although a few of the larger molding plants, especially those doing cold molding, have equipment for making molding compounds, it is not proposed to describe such equipment here. Most sizable molding shops, however, have pre-forming and some other equipment for handling and/or treating compounds purchased ready for use, and all shops have means for weighing out charges of molding compounds. Automatic scales for weighing specified amounts of compound and feeding it into suitable containers for individual charges can be had, or simple postal or drug scales may be used with hand weighing and measuring of charges. Sometimes such weighing is done at the presses by the press operator, who may have time to perform this simple operation between mold chargings, but in large shops the charges are often supplied in cups or bags filled in a weighing room and delivered to the presses in tote boxes, trays or the like. Some large shops have chain conveyors for supplying containers filled with individual charges of powder or pre-forms. In still other cases, especially where flash types of molds are used, a volume measurement of the charge from a pail or drum of compound may be made at the press. For hot-molding compounds, however, specific gravity often varies and with it the volume to fill the mold also changes, hence, unless the variation can be taken up in flash without undue waste, weighing of charges is usually preferred, or a pre-form or known weight is used.



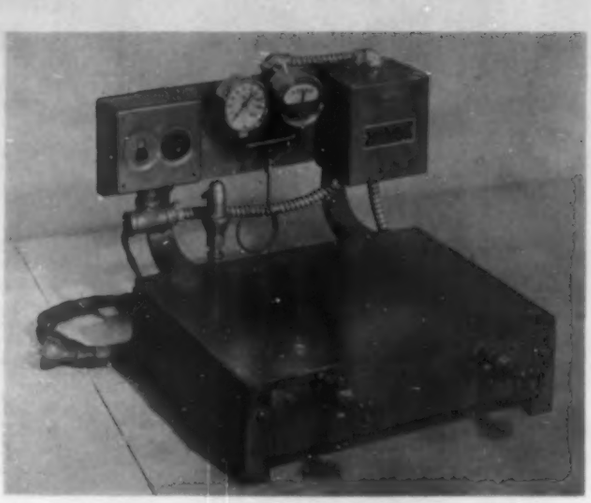
Above—Cambridge portable pyrometer for measuring mold temperatures. Cambridge Instrument Co. Below—Electrically heated molding press platen made by Harold E. Trent Co.

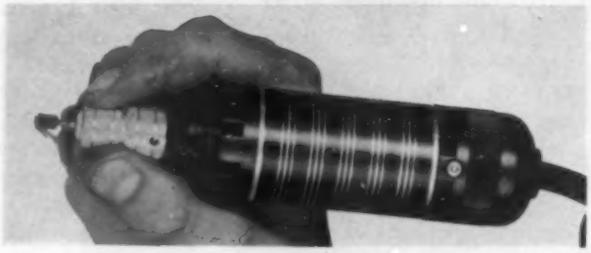
Weighted cylinder type of hydraulic accumulator for high pressure systems made by Farrel-Birmingham Co. Inc.



Pre-forming involves the use of a machine which converts the powdered or granular compound into a compressed tablet or "pill" of the required size, shape and weight. As the pre-forming is done under considerable pressure, the volume of the pill is considerably less than that of the powdered charge. It is not necessary to allow so much space in a positive mold for compressing the charge as if a powdered charge were employed. Pre-forms add to convenience and rapidity in charging and sometimes result in more satisfactory flowing in the mold with consequent improvement in the molded piece or less chance of displacing inserts.

There are several makes and types of pre-forming machines, but in general they are classified as single-punch and rotary or multiple-punch machines. The former is commonly used for making large and irregular shaped pre-forms, and the latter for cylindrical, spherical or other standard shapes in small to medium size. The single-punch type may turn out 100 or fewer pre-forms a minute and the rotary type 1,500 or more per minute. As size, weight and volume of pre-forms are reasonably uniform, separate weight or volume measurements may be dispensed with and convenience in handling promoted. Pre-forms are of particular value in large multiple-cavity molds where it would





Above—Electrically heated table for heating preforms or thermoplastics made by Standard Tool Co. Below—Hand-ee Grinder for polishing molds or other fine work in a molding plant. Chicago Wheel & Mfg. Co.

be a slow and difficult process to fill each cavity with a separate charge of powder. For such work, the tablets are often placed in loading frames so made that when the mold is ready for charging, the frame is put in place, a slide releasing the pre-forms is pulled, and the entire mold is filled in this single operation.

Besides convenience in charging, which is sometimes done automatically, pre-forms are easily pre-heated either on trays in ovens or on hot plates adjacent to the presses. This pre-heating involves either an oven, usually electrically heated, or a hot plate which may be heated by steam or by electric means. Either type of heater can be had in more or less "standard" forms. Pre-heating shortens the molding cycle, as the press can be fully closed sooner, and sometimes results in a superior molding in which flow marks are less pronounced or invisible.

Equipment for cleaning moldings

Although, as previously noted, moldings as taken from the press are substantially ready for use (that is, those of the hot-molded type), it is almost always necessary to remove fins at the mold parting and around core pins, as well as in holes. These operations are commonly called "cleaning" and in general require considerable equipment. Much hand filing is done, but several types of machines are employed, especially where the product is made in large quantities. Many moldings can be effectively cleaned by using special cleaning tools designed to force the molding through a shaving die, at the same time forcing a punch or punches through any holes which may

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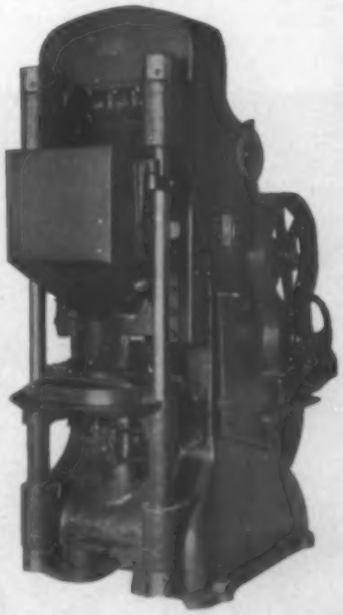

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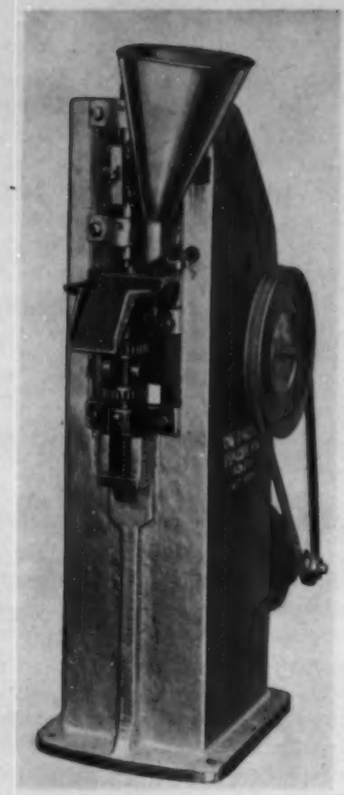
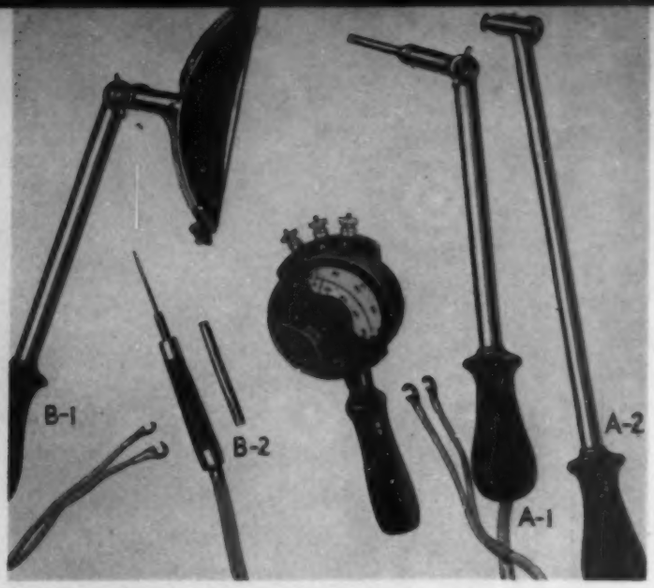


The new Kux-Lohner single punch press for rapid preforming. Tablets may be made from smallest diameter up to 4 in., and depth to fill up to 6¼ in. Steel frame castings insure rugged construction adaptable to high pressures up to 150 tons

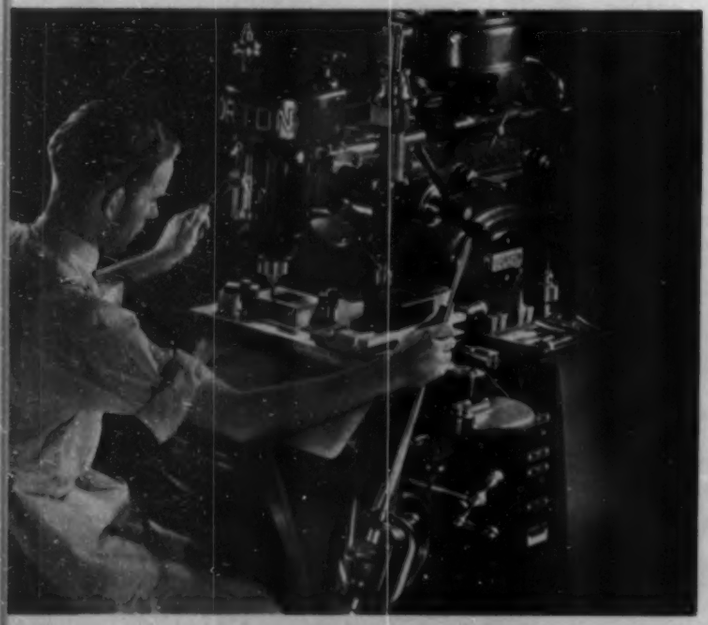


A few of the various pyrometers made by the Pyrometer Instrument Co.

have fins. This may be done in any simple form of press, often hand or foot operated, or in a special fixture in which a lever operates one or several tools simultaneously, perhaps completely cleaning the pieces in this one motion. In other instances, especially with small moldings made in large quantities, these may be fed by hand into a dial fixture which carries them under a small power-driven press or under a drill press or tapping machine which performs the cleaning and perhaps some supplementary operation, such as tapping a hole, which has been molded to size.

External fins are often removed by tumbling, especially when the fin is light. This may be done in a barrel with a continuous or intermittent screen, or even by tumbling in a closed barrel with a suitable charge of "cutting-down" abrasive and wooden shoe pegs, and perhaps with subsequent tumbling in a polishing compound to remove scratches made by an abrasive. Tumbling does not remove fins from small holes but serves well with many small parts, such as buttons, bottle caps, spectacle parts and the like.

Much cleaning is done on belt sanders, especially where flat surfaces or straight edges are involved. Or a rotating abrasive disk may serve the same purpose. Other cleaning is done in small lathes. When the dull unfinished line resulting from fins must be removed, the piece may be polished on a fabric wheel.



This is a Gorton Duplicator with tracer head and high-speed spindle for reproducing molds in steel instead of hobbing

Heat treatment of moldings

Parts produced by the cold-molding process come from the press in a highly compressed form, but are not ready for use until they have been baked to set or harden the binding agent. Such baking requires several hours and is commonly done in metal ovens in which the temperature must be closely controlled and the heat evenly distributed. The ovens may be gas or oil fired or heated electrically, but thermostatic control of heating is necessary and indicating or recording pyrometers are convenient if not essential equipment. The properties of the moldings depend, at least to some extent, on correct heat treatment. Such ovens with their accessories are thus important items of equipment in the cold-molding plant.

Although moldings produced from phenolic compounds by the usual hot-molding process do not in general require any subsequent baking, their dielectric properties are improved and dimensional permanence is sometimes promoted by baking subsequent to molding. In consequence, this practice is followed in some molding shops, particularly where accurate instrument parts are produced. It requires, of course, baking ovens of such size and type as to meet the production demands imposed and such ovens are a part of

Portable blower for clearing molds and presses of flash or for any cleaning operation where compressed air will reach difficult places. Made by Clements Mfg. Co.

the equipment of some shops. Trays, shelves, wire baskets or their equivalent are used for the moldings while they undergo such heat-treatment.

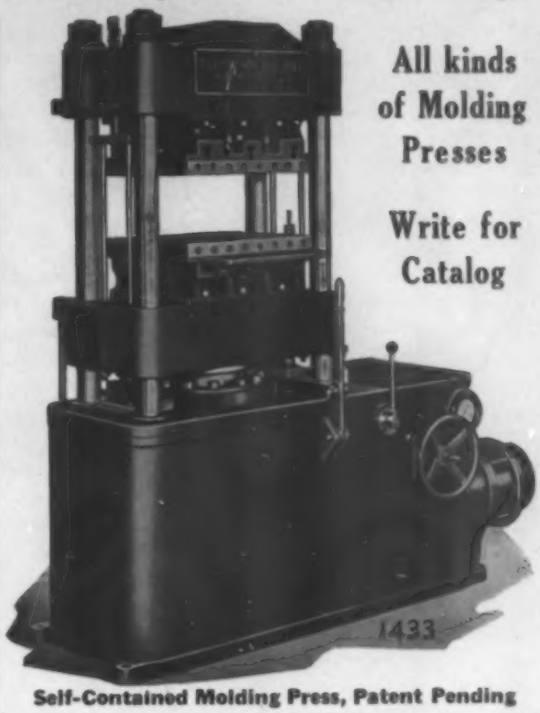
Inspection and testing equipment

Relatively few molding plants require extensive equipment for inspection or for testing the molded product, but such apparatus is employed in some plants while others with laboratories for checking and control purposes have a considerable amount of such equipment—some physical, some mechanical and some electrical. Gages for size checking are much the same as those employed in checking metal products and need no description here. Physical tests sometimes include hardness measurements or even impact strength (especially with cold moldings) and tensile strength. Where dielectric properties are important, certain tests of such properties may be made. In general, however, such tests are made by independent laboratories, but are sometimes quite important, especially on parts purchased under government specifications. Moisture absorption tests are sometimes made with the simplest form of apparatus, especially boiling in water to check on the cure of urea moldings. Some molders check the specific gravity of certain compounds, especially in cold molding work where volume measurements are common and the required gravity must be known or altered to give the results required in the molded product. Simple volume and weight measuring equipment suffice in such cases.

Conclusion

Other details, almost countless in number and variety, might be given in a more comprehensive treatment of molding plant equipment, but the foregoing outline is sufficient to give those interested some notion of the character and extent of equipment needed. Molders are specialists and face problems rarely encountered in other manufacturing work. In view of the complexities of these problems, they are deserving of much credit for the uniformly high quality of product they turn out.

French Hydraulic Machinery



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2147 LEXINGTON STREET CHICAGO, ILL.

Extrusion molding

(Continued from page 252) of the plastic occurs within the mold. The extrusion machine itself is arranged for handling the material through all preceding events. The functions of a complete extrusion molding machine include clamping the mold halves, feeding the material, heating the material to plasticity, contacting plastic material chamber with mold inlet, extruding plastic material into mold cavities, opening the mold and ejecting finished articles.

The material in dry granular form is automatically fed from a hopper into the machine as required. A reciprocating plunger forces the material through a heated chamber where it is brought to the required plasticity. In machines of large capacity, the material passes to a second chamber, also heated. In this the plastic is subjected to a high pressure for extrusion into the mold. In smaller machines but one chamber is employed for both plasticizing and extrusion. The two-chamber system introduces the extra requirement of closing communication between the two while extrusion takes place.

The outlet from the extrusion chamber is through a small orifice in a nozzle. The end of the nozzle of smoothly rounded contour fits into the inlet in the back of the inner half of the mold. A tight seal must be maintained at this junction during extrusion to prevent leakage of material. The two halves of the mold are carried on platens, one movable to and from the other for closing and opening. This is the only portion of the machine which at all resembles the regulation molding press.

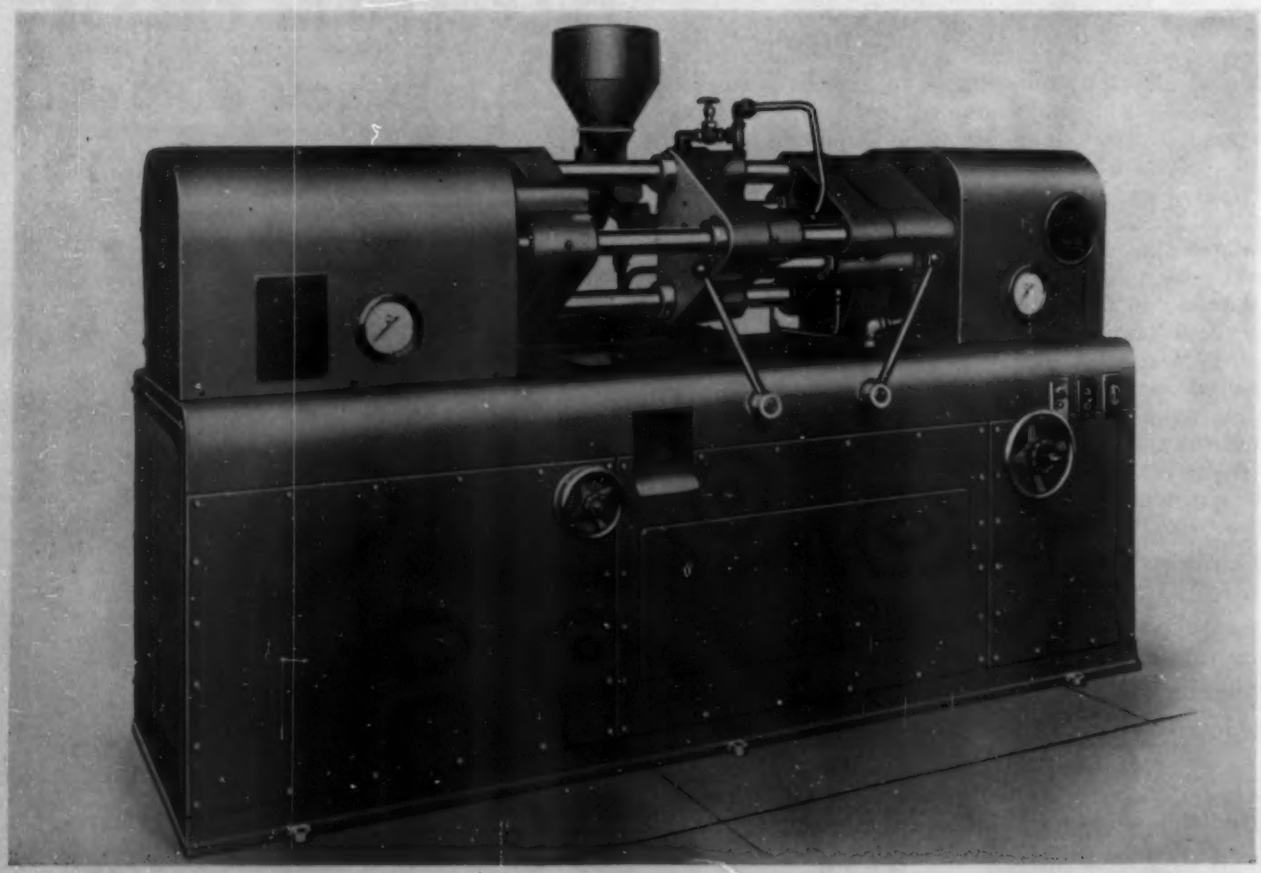
The inner platen has a floating action for bringing the mold inlet in contact with the extrusion nozzle. Communication from the mold inlet to the cavities is via passage known as the gate and runners. The gate is a hole of circular section and enlarging diameter extending from the inlet to the parting surface of the two mold halves. The runners are lateral distributing channels, connecting the inner end of the gate with the individual mold cavities. In a single cavity mold the gate usually feeds it direct without a runner.

Each lateral runner usually enters the mold cavity at a sharp edge through a flat thinned-down orifice. This provides for best distribution of the plastic and also clean, easy separation of the sprue from the finished piece. The cavities may be located in either half of the mold; the runners, however, are almost always along the surface of the outer half. This facilitates ejection by the tendency of the molded part to remain with the outer half, when the mold is opened.

Successful extrusion mold design depends to a great extent on the gating provisions for feeding the cavities. This involves proportioning of the gates and runners to the shape and size of the parts to be produced. Both halves of the mold are chambered for the circulation

HYDRAULIC PRESS MFG. CO.

A modern extrusion press which operates hydraulically with all functions synchronized for speed operation



Rear view of two extrusion presses showing the feed hoppers and heating chambers. (Courtesy Erie Resistor Corp.)

of cold water to quickly chill the plastic after the cavities are filled.

It is imperative that the cavities be entirely filled with the material while perfectly plastic and that pressure be maintained until a set takes place. Proper operation in these respects will assure an output of high quality with a smooth luster finish free from flow marks or shrink marks and with a perfect weld where the flow ceases. The molded parts are automatically ejected as the mold halves are separated, the clamping member receding to its initial position. Finishing is confined to merely removing the gate and sprues, which is invariably a simple clipping operation.

Extrusion molding equipment

From the procedure just outlined it is apparent that the extrusion molding machine must fulfill a number of important functions. Furthermore, these are necessarily coordinated for uniform results. This all requires a much more extensive mechanism than the regulation compression molding press. European designs of extrusion molding machines have included a number of different types. Operation has been by hand power, mechanical drive or hydraulic pressure. The hydraulics have usually been operated from a conventional water pressure accumulator system.

The first American extrusion molding machine was

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initially developed about two years ago. It is fully hydraulic. However, unlike its European predecessors, the American machine is entirely self-contained with its own electric motor driven hydraulic power plant. Oil is used as the hydraulic fluid medium. This machine is best described in connection with photo on page 290 which illustrates the current model.

Three double-acting hydraulic cylinders and rams provide all the basic machine movements. A ram at the rear actuates the initial material feed plunger, moving it through the plasticizing heater. A ram working out of the left hand housing traverses the die clamp platen. A ram working from the right hand end forces a plunger into the extrusion chamber for extruding the plastic into the closed mold. This exerts a maximum unit pressure of about fourteen thousand pounds per square inch on the plastic.

The hopper feed, which delivers the granular material to the machine, is actuated by a mechanism controlled by one of the ram movements. This provides for automatic proportioning of the feed to the rate of material consumption. The die clamp pressure required bears a definite relation to the pressure of extrusion. The molten plastic acts in some measure as a hydrostatic medium, momentarily transmitting an appreciable portion of the initial unit pressure extrusion into the mold.

By moving two levers, the operator causes the press to complete a cycle. (Courtesy Erie Resistor Corp.)

Showing a mold installation where six pieces are produced with one cycle. (Courtesy Erie Resistor Corp.)

Both the clamping and extrusion pressures are independently regulated by means of the two hand wheels at the front of the machine, to the left and right respectively. These regulate the output of the two hydraulic generators which provide the operating pressures. The speed of extrusion is governed by another adjustment, which can be set to the desired rate without affecting any other ram movement. The plasticizing and extrusion chambers are heated by hot oil flowing between inner and outer walls. The oil, which is a special grade of very high flash point, is in turn heated electrically and circulated by a small motor driven pump. The temperature is automatically regulated by an indicating thermostat.

Control of all machine movements may be either manual or automatic. For the former, but two hand levers are required, located at the front of the machine. Automatic operation provides for predetermined timing of each event of the entire cycle, all properly correlated. The operation may be either semi-automatic or full automatic, according to the setting of the control. With semi-automatic performance the operator merely restarts the control for each cycle by means of a push button. During the cycle he may devote his time to inspecting the output of the previous operations. When set for full automatic control operation is continuous, each cycle re-

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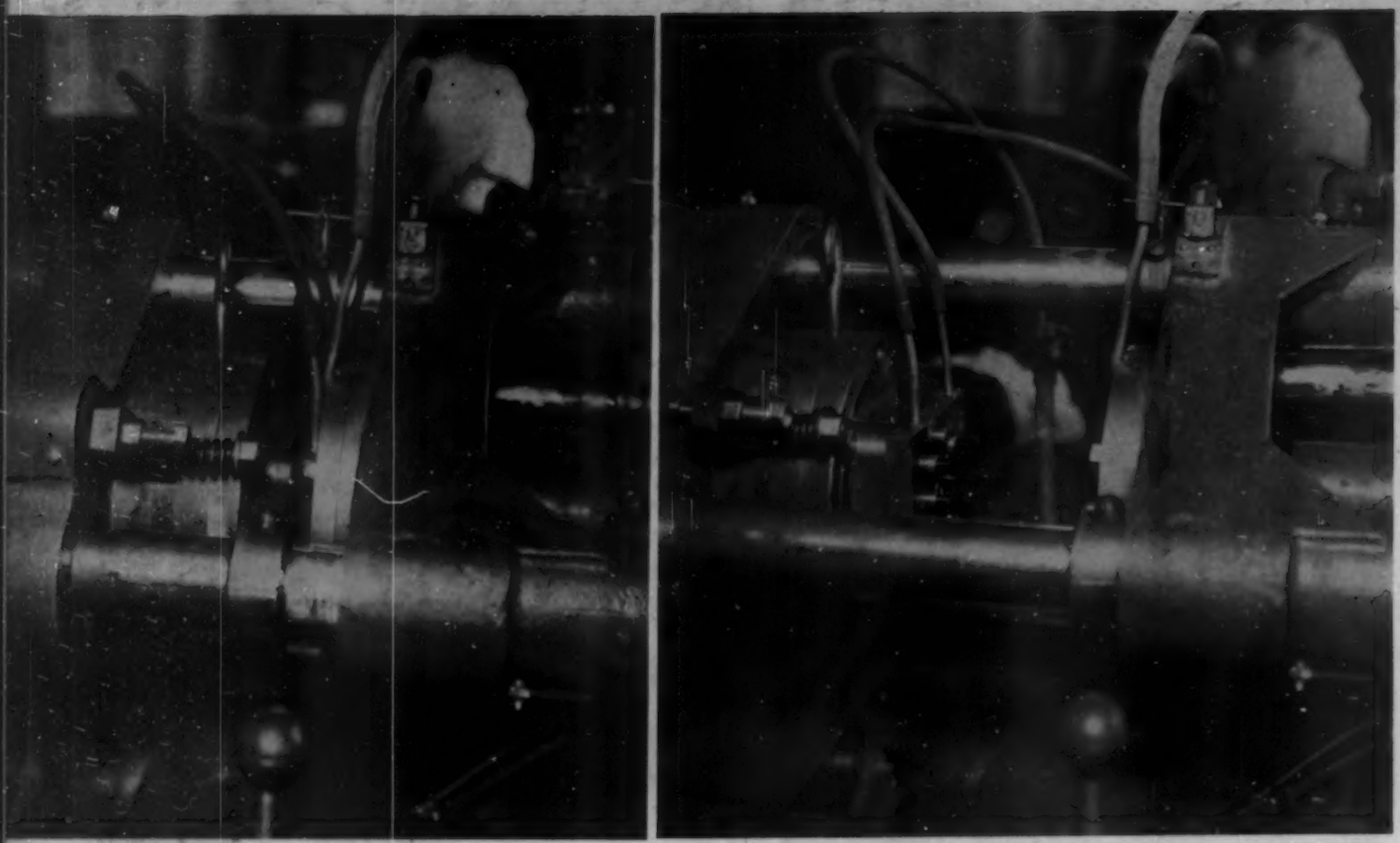


Left—The mold is closed and sealed with hydraulic pressure. Right—When the cycle is completed the hydraulic rams to which one half the die is fastened returns to its initial position. This shows the finished molded parts as they appear after the die opens. Ejector pins remove them from the mold. (Courtesy Erie Resistor Corp.)

starting automatically. Change from one mode to another can be made instantly.

It is not intended here to leave the impression that extrusion molding is to replace the compression form of molding. On the contrary, compression molding will always have its place—and a prominent one in plastic molding. But extrusion molding carries plastic possibilities that are much farther advanced toward the desired goal, through pronounced economies on the work it is best fitted to do over the compression method—and in permitting a much broader application than is possible with the latter method.

To avoid confusion on this score, it is advisable to say here that the production of the extrusion molding press must come within the following four specifications: First—The quantity of material that can be heated. Second—The weight of any one shot is dependent upon the size of the press involved. Third—The number of shots per minute—the modern extrusion press will cycle fast enough to deliver six shots per minute. Fourth—The size piece that the machine will clamp. This is determined by the clamp pressure available.

Any one of the four above mentioned ratings determines the production capacity of the press and the size to install. It should also be noted that the ability to cool the die will also play an important part in its output and is usually the limiting factor in the number of cycles per minute that can be accomplished. The matter of die design should be given careful attention because for every piece there are several possible ways of casting and it is advisable to select the best. Cooling and ways of ejecting the pieces are the details to watch most carefully, and if the machine is to be operated automatically the ejection is very important.

Its future

The future of extrusion molding is limited only to the ingenuity of those responsible for the development of the equipment, the materials used, and the engineering skill of the molder. Particular emphasis stresses the molder because it is quite easy to secure the wrong impression concerning the simplicity surrounding extrusion plastic molding, due chiefly to the comparatively small investment in equipment to start—and the savings in mold costs. But, like any other business, it requires a thorough understanding of the market—the molding cost factor—what it is possible to do with the equipment—and above all, an engineering background which can function both in favor of the molder and those manufacturers whom he would like to have as customers.

PRODUCT DEVELOPMENT

Resin Bonded Plywood

Plastics in Dentistry

Resin Treated Fabrics

Plastics Seldom Seen

Resinous Paint for Industry

Resin Bonded Abrasive Wheels

Pages 295 to 310

Resin bonded plywood

BY H. S. SPENCER*

SINCE the days when the cavemen with sticks and stones knocked breakfast out of the trees, killed wild game with sharpened wooden spears and fought each other with crudely fashioned clubs, wood, that amazing product of Mother Nature, has proven itself of essential importance not only in the mere subsistance of the human race but also as an indispensable basic material.

Throughout the years of development of new materials, wood has maintained its position as an indispensable basic material: true, science has stepped in and made tremendous improvements such as, for instance, impregnation to prevent dry and wet rot, methods of cutting to reveal more fully its natural beauty and, last but most important of all, an entirely different method of construction which we today call plywood.

Plywood is not a new product. Its origin can be traced to the Egyptians of thirty-five centuries ago. It was then an art to split wood into thin veneers and glue onto heavy blocks to produce a beautiful natural finish or intricate mosaic designs, but today it is a tremendous industry. Its growth can be attributed to constant changes in methods of manufacture, better tools and development of new adhesives or glues, and it is a recognized fact that the secret of successful plywood manufacturing lies in the glue line. This spurred science on to the development of better glues. Improvements were made in vegetable and animal glues, casein and sodium silicate were introduced, followed by blood glues, and now the phenol-formaldehyde synthetic resin glue.

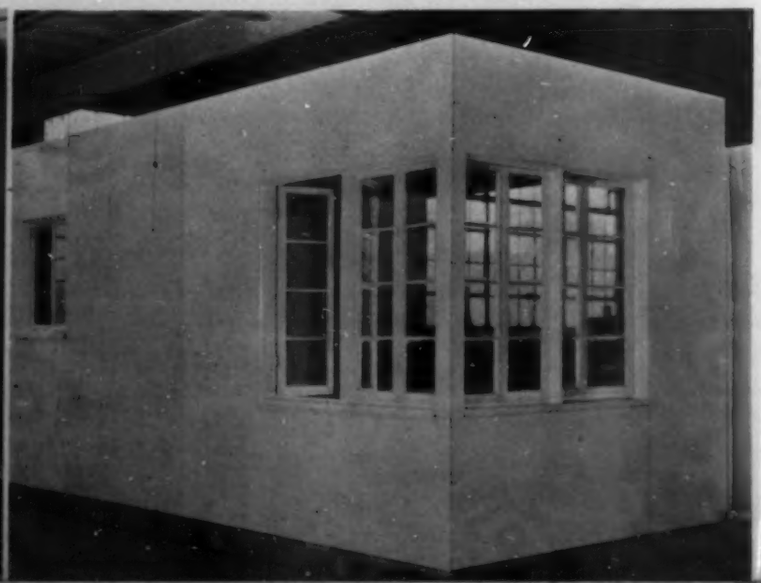
The early work on the phenol-formaldehyde resin glue was done about twelve years ago and created considerable interest in the plywood industry. However, costs were prohibitive. The product was called back into the laboratory and, after seven years of intensive research work, a product was developed which was far superior to any other form of glue on the market and competitive in price. This early achievement and success should be credited to a German research and chemical manufacturing company. Since then experimental work has continued and improvements made, costs reduced and various types of glues to fit every requirement produced.

We invite you to join us on a tour of inspection of one of these large plywood plants and allow us to show you the methods used by modern science in producing wood that is far superior to wood produced by Mother Nature. Let us enter at the rear gate. Here we see rafts of logs tied at the docks and being pulled out by giant hoists and piled in large piles in the yard. Some are brought in by rail, still other logs by truck, but all are piled neatly in the yard. At the other end of the yard is a huge pond where logs are stored under water to prevent damage from the sun, mildew and various fungus growths leading to decay. We find workmen removing logs from the pond, loading on small cars and transporting to the cooking vats where the logs are steamed in practically boiling water for days to soften the texture so that they may be cut on a slicer or lathe without tearing or breaking.

Men with derricks remove the cooked logs from the vats, strip them of bark, and transport them to the lathes. Here we are impressed with the gigantic size of the equipment, the logs 6, 8 and 10 feet in diameter and 6 to 12 ft. long are centered in the lathes, the knife placed in position and power applied to rotate the log. At the front end of the lathe two men are taking away a continuous strip of veneer, cutting to length and stacking in neat piles. Unbelievable, but there it is, astonishingly simple, more like unwinding a roll of paper, but this is wood in uniform thickness which can be accurately controlled from 1/100 in. to ¼ in. We are impressed with the huge machines cutting thin veneers from the logs longitudinally, and follow the rotary and slice cut veneers after trimming into the drying department where huge driers 8 ft. and 10 ft. in width and 40-50 ft. in length dry out the moisture in a continuous operation. The moisture is reduced

* General Plastics, Inc.

At the left is the Auditorium of RKO Roxy Theater, Rockefeller Center, N. Y., in which ornamental Haskelite was used for interior finish. Right—Prefabricated Phemaloid house of Haskelite. (Photos, courtesy General Plastics, Inc.)



to 4-6 per cent. Veneers are then sorted as to grade, grain and size. The pieces are laid up to panel size and passed through an automatic taping machine. The purpose of the tape is to hold the various pieces that compose a single ply in position ready for gluing.

The gluing operation with conventional types of glues consists of passing the veneers through a steel roll glue spreader, laying up the panels and applying pressure either in a screw press or stacking 25-50 panels and applying large clamps specially designed for this purpose and allowing to set for periods of 2-12 hrs. depending upon the type of glue used. Panels are then ready for sanding.

The phenol-formaldehyde glues require entirely different procedure. First we wish to point out that there are four different types of phenol resin glues: 1. The liquid resin glue. 2. The film glue. 3. The colloidal glue. 4. The dry resin glue.

The liquid resin glue, one of the first developed, was found rather difficult to handle due to its very fluid condition. It had a tendency to soak through the veneers, staining them and produced a glue line of uncertain strength. This type of resin glue was not very dependable. The difficulties with the liquid resin glue led to the development of the film glue. This type is made by impregnating a sheet of .001-in. kraft paper with a thermosetting resin and drying it to a definite point. This gives the plywood manufacturer a sheet of glue which is very uniform and cured to a point where the glue remains between the plies of wood. There is no soaking of resin into the wood and no staining of veneers. However, this method has its disadvantages in the fact that the plywood manufacturer cannot vary the amount of glue as is quite necessary with the various types of wood.

The colloidal resins are merely colloidal suspensions of a synthetic resin in water. The objection to their use lies in the great amount of moisture which enters the wood and which must be disposed of. However they can be used and by carefully controlling the process, excellent results are obtained.

The dry powdered resins are simply synthetic resins finely ground. These are applied by several methods and have proven themselves to be the most satisfactory form of resin glue.

With the exception of the film glue and some forms of powdered glue, all are applied on the wood with a glue spreader in exactly the same manner as the vegetable or casein glues. The film glue is simply laid in between the veneers dry. One manufacturer prefers to sift dry powdered resin onto panels and wet slightly with solvent. Others prefer to use dry resin in suitable solvent—spreading it in standard glue spreader—so that in general the methods of application differ with the type of glue used.

After spreading, the panels are laid up to proper thickness, 3, 5, 7, 9 ply or more, but almost always an odd number, and pressed in huge steam or electrically heated hydraulic presses ranging in size from 12 in. x 12 in. to 10 ft. x 10 ft., having from 1-20 openings at temperatures of 280-310 deg. F. for 4-20 minutes, depending upon thickness, at hydraulic pressures of 150-400 lbs. per sq. in. depending upon the hardness of the wood. The panels are removed from the presses hot and immediately dipped in water to eliminate checking of wood due to excessive drying out. They are then air dried, trimmed and sanded. The operation is now complete. The panels are ready for shipment and commercial use.

The phenol-formaldehyde glue as applied on the veneers does not possess any of the characteristics of a glue. In all cases it is a dry film or coating. If solvents or water have been used, these are dried out before pressing, although in some cases it is not necessary to do so. During the pressing operation the resin softens, knits the fibers securely together and reacts chemically to a hard, strong, insoluble and infusible bond. The bond produced in this manner is unaffected by heat, water, acids, alkalies, or any solvents. It is an inert glue which can only by destroyed by fire. Wood's greatest handicap is its inflammability. Fortunes have been spent in an attempt to produce a satisfactory fireproofing treatment, with little success, but with resin glues and thin asbestos paper incorporated in the construction of plywood, panels can be made which will resist the flames of a blow torch for a period of an hour without burning.

Wood, with all its points of superiority, when used as veneers presented innumerable difficulties in the past which were extremely difficult and in most cases impossible to control, such as peeling, due to expansion and contraction, and gradual weakening of the glue line through lack of water resistance, attack by vermin and fungus which found the old conventional

GENERAL PLASTICS INC.

Lobby of "SS. Washington" in which Haskelite paneling was used. Right—Interior of Phemaloid house

Haskelite display background, General Motors Salon, Waldorf Astoria Hotel, 1933 (Photo, courtesy General Plastics, Inc.)

glue line a fertile pasture. Resin glues have eliminated most of these undesirable characteristics of plywood. They don't cure all ills by any means, but due to their total insolubility in water, peeling has been entirely eliminated. For instance, boiling water which breaks down and delaminates all ordinary plywood in approximately 5 minutes, has no effect on resin bonded plywood whatsoever. In fact, one of the large manufacturers has included in his specifications on this type of wood a test which calls for 5 cycles of 1 hour boiling in water and 1 hour drying at 300 deg. F. The glue line must not show the slightest tendency of failure, a total of 10 hours in contact with water at its boiling point and no failure. Outdoor weathering tests carried on for a year showed that the unpainted wood breaks down before the resin glue line.

Is it any wonder that resins are being recognized as a superior glue? Another very interesting point is that the resins to a certain degree possess antiseptic properties of phenol and formaldehyde and as a result produce a glue line which is entirely vermin-proof. Panels, when exposed to vermin over long periods, were affected only in spots. The glue lines were untouched. Ordinary plywood panels made with common glues under the same conditions and time were completely destroyed.

Resin glue adds value to plywood and has extended its uses tremendously. It is being used now where it would not have been considered a few years ago. Today we find barns, prefabricated houses, outdoor signs, street car and motor truck sidings, concrete forms being built of this new material. In fact, it can be used advantageously on any application where a strong, light material is desired. It has a definite insulating value as for example a product made from Douglas fir bonded with a phenol resin glue,[1] has a thermal conductivity comparing favorably with many insulating materials. A wall constructed of two such panels with dead air space between will give excellent insulation.

These resin bonded plywoods are structurally strong. A ½-in. sheet of 12-in. wide five-ply fir, for example, supports 950 lbs. as a beam with 14-in. span with outer ply grain parallel to span, and much more with grain at right angles to span. This means studs on wider centers, saving lumber or steel members. Common thicknesses: ¼ in., ½ in., ¾ in.; common sizes: 4 ft. by 4 ft., 4 ft. by 6 ft., 4 ft. by 8 ft., 4 ft. by 10 ft., 4 ft. by 12 ft., 3 ft. by 12 ft.

Wood, with a specific gravity of 0.45 for fir, is one of the lightest of construction materials. Actually, a square foot of ¼-in. plywood weighs but 9.5 ounces, and a panel 3 ft. by 12 ft. weighs but 21 lbs.—light enough for one man to handle with ease.

The market for this resin-bonded plywood is a large one, for by this type of manufacture plywood is no longer a substitute for lumber but a real synthetic lumber, more uniformly durable and stronger than the original wood. Think of this new material as a door, wall panel, in ship construction: very light in weight, extremely strong structurally, will resist a direct flame for twenty-four hours with no effect other than the charring of the surface, yet this door or panel is real wood.

Phenolic resin plywood has been used to construct entire motor cruisers, even including the keel, providing light construction on this ocean-going boat, giving it speed, increasing the cruising radius through fuel saving. While the phenolic resin manufacturers are optimistic over the future for their bonds and believe a large market is available for their products, they concede that there will undoubtedly be an active market for cold glue plywood, at least for some time.

That the phenol resin bonded plywood manufactured through the hot press system will open new markets for plywood is without doubt true, as in the instance of boat construction. Cold glue plywoods could not even be considered for under-water parts as rudders or keels. The flexibility of the phenolic resin also eliminates the stripping of the face veneer. Plywood bonded with a phenol resin may be rolled up without stripping, whereas the usual airplane type of plywood is considered satisfactory if two sides of a 24-in. sheet can be brought together without breaking.

Resistance to tearing strains or shear in both dry and wet tests is said to have shown that the new veneers have three to four times the strength of plywood bonded with common glues, making them desirable in airplane construction for wings, propellers, etc.

For all types of uses where the wood is subjected to moisture and weathering conditions—baked by the sun, soaked by the rains and melting snow—phenol resin plywood has no competition with ordinary materials and is finding ready markets for such applications as truck bodies, trailers, houses, etc.

It is anticipated that industrial construction, as warehouses, out buildings, construction camps, portable and prefabricated houses, will all prove markets as will marine construction, as lighters, ferries, tugs, canal boats, freighters, barges, houseboats and motor cruisers. In the modernization of stores, offices, homes, for cellar and recreation rooms, play rooms, veranda ceilings, attic rooms, restaurants, bars, cocktail rooms, because of their stability, easy handling and low installation cost, these new materials will find a ready acceptance. While they are basically plywoods they are a new kind that will not delaminate, are impervious to water, a substantial building material of superior, lasting characteristics difficult to equal.

[1] Refers to Dure-Z-Wood

Plastics in dentistry

RALPH H. BOOS, D.D.S.*

THE great interest created in the subject of mouth health and a desire to improve the present service of dentistry have developed a need for new materials to be used in the construction of dental bases for artificial teeth. Dentistry in its endeavor to fulfill this material need has called upon the scientific research laboratories of industry for assistance.

Materials to be used in the human mouth must meet conditions quite different than for any other use. A dental base material must be compatible to the human tissue, resist the secretions of the oral cavity, and be very pleasing and natural in appearance. The material must be fitted to irregular surfaces and therefore must possess reasonable strength in order to withstand stresses that are constantly applied from many directions. The material must also permit the manipulation required for processing and construction of a set of artificial dentures. It must be moldable to an individual mold as no two dentures are alike, which voids multiple production.

Many of the qualities required can be tested in the chemical laboratory; others cannot, as up to the present time it has been impossible to duplicate—out of the human mouth—the many conditions to which artificial dentures are subjected in the human mouth.

Due to these rather unique conditions there have been many disappointments. Materials possessing many good qualities have proved costly experiments when placed to the practical test. Materials that have produced gratifying results in hundreds of cases and even after every conceivable test in and out of the mouth have proved to be a costly venture when manufactured in large quantities and placed in general use. The curing must be of short duration and the form must remain stable in or out of the mouth. The material must be strong yet have a certain elasticity under mouth conditions. It should conduct thermal changes to a limited extent. The surface must be dense and non-absorbent.

The color must be a pleasing natural pink, likened to mouth tissue, and the life of the color must be quite permanent. The material must not be costly and must have a reasonably good shelf life. To provide against unusual conditions the material must be repairable and form a good union with the original processed plastic. Vulcanite has been the old standard of dental base materials for many years.

Data of interest take us back to 1925 when a material known as Ixolain, one of the phenol-formaldehyde types was being marketed to some extent in England. This material was used exclusively as a facing for dentures. At the same time, in Germany, a material called Oberlander was available for the same purpose.

Owing to the simplicity of the technic of Ixolain, it quickly superseded Oberlander. After testing Ixolain for several months, arrangements were made to import this material from England, and in the fall of 1925, several importations were made and the material sold through dealers to laboratories and dentists in the entire country. Many baffling problems arose with the introduction of this material as no pink resin material of any type had appeared on the market—those who saw it became enthusiastically interested, but as they had no understanding of the material, there were many more failures than successes. When making facings with this new material, bubbles occurred, and it was believed this was due to the resin boiling under the temperature and pressure required to cure the material. Alcohol was tried out, and after a series of successes it was thought that alcohol was preventing the resin from boiling, and the alcohol technic became standardized.

Difficulties were encountered in accurately curing the material. Thermometers, pressure gauges and gas regulators were in many cases registering inaccurately. This inaccuracy necessitated a great deal of detail to get the proper result with Ixolain. In the fall of 1926, at the Philadelphia International Dental Congress, Iteco first made its appearance and was shown at this meeting, but was not for sale. In months to follow it was offered in a restricted way to dentists on the Western Coast. The method of curing Iteco at that time was to boil it for a period of something like twenty-four hours. They later on adopted the alcohol technic, and cut down the time of cure.

In the winter of 1927, a phenol resin similar to Iteco was offered under the name of Porcelite which rapidly supplanted Ixolain. In about a year's time a similar resin named Coedal was on the market.

In the interval succeeding the difficulties with Porcelite, Hecolite became popular, and in the wake of Hecolite has followed a number of cellulose nitrate materials sold under different names. Stryol resin has been sold under the name of Tepperite, and vinyl resins under the names of Resovin and Vydon.

As early as 1914 attention had been devoted to the development of a denture material from resinoid. Knowing the many properties of resinoid, it was apparent that a good denture material could be developed, but that considerable research and experimentation were necessary. Sometimes hundreds of tests and formulas were tried before a single property was brought to a point where it proved satisfactory in this material. It was not until the Fall of 1928 that a material, apparently suitable in many respects, was offered in a limited way to dental laboratories for experimentation. This material was called Glycene and even though there were certain deficiencies, it was the dental industry's general opinion that this denture material was definitely superior to others which were known up to that time.

Development was slow, but it was always toward a better material, and eventually, in the Spring of 1932, a new denture material—Luxene resinoid—was announced. In the three years following, this product proved its ability to meet the many requirements of a good denture material.

At the present date there are many plastic denture materials on the market and more being introduced; Duratone, Endurol, and Aldenol are recent contributions in the phenol resin type. Luxene, however, is among those enjoying the most popular acceptance.

* Henry P. Boos Dental Laboratories

Phenolic resin-coated fabrics

BY DON MASSON*

THE diversified growth of phenolic plastic materials might be likened to a tree with its trunk and primary limbs and then with the hundreds of branches and off-shoots from these branches. Among the off-shoots in the plastics industry is the introduction of special flexible resinoids for the coating of fabrics. Research to develop coating materials of better chemical resistance and durability under chemical strain was recognized as a likely field of work because of the combination of properties to be found in phenolic resinoids. This research eventually led to the creation of a special synthetic flexible resinoid material capable of being applied by a calender. This product might better be described as a dough-like mass. It lends itself very well to the production of flexible fabrics which are resistant to most chemicals, water resistant, and have long life. In other words, the coated material is flexible, waterproof, durable, and resistant to most oils, greases and chemicals.

With this flexible phenolic resinoid it is possible to coat cloths in a wide range of colors. The properties of the finished product vary greatly with the amount of coating, the color, the type of cloth, and, in the case of chemical resistance, with the degree that the resin is polymerized. These coated fabrics[1] have certain properties peculiar to the phenol resinoids and dissimilar in many respects to fabrics surfaced with other types of coatings.

Uses for this resin-coated cloth are many and varied. It is used for the production of waterproof adhesive tape and in the production of insulating and binding tapes in the electrical field. In clothing it is being used for the manufacture of raincoats for both men and women, sportswear, beachwear, and lining material. It can also be employed for upholstery material and slip covers, as well as modern draperies. Closet accessories, displays, dress trimmings, belts, dental and laboratory aprons are other uses.

The metallic finishes produced from metal powders, ranging from dark colors to a light gold or polished copper, provide beautiful effects. As fruit juices and alcohol will not stain the material, it makes ideal covers for bridge tables. Burning cigarettes have less effect on it than most materials used for this purpose. There are dozens of places in the home where this new cloth can be used to advantage; for example, curtains, valances and slip covers. The material drapes very well and the metallic finishes and brighter colors add a pleasing note to surrounding furnishings.

Resin-coated fabrics are used for shower curtains where resistance to soap and alkali is important. They can be used for table covers where hot pans and dishes are placed. Since they can be washed with ordinary cleansing agents without harmful effects, shelf covers, decorative screens, doilies and table runners are other household applications that suggest themselves. Having resistance to salt water and salt atmosphere, this type of coated cloth can be employed widely in the marine field for such applications as cushion and seat covers, tarpaulins and slickers.

Asbestos coated with phenolic resins is being used for laundry roll coverings with good success. It has many advantages over present type coverings and should find increased use in this field within the next few years. Phenolic resin-coated fabrics are still in the early stages of development, having been introduced a little over three years ago, but the future should bring forth some interesting improvements which will provide better materials for industry's requirements.

* Bakelite Corporation

[1] Marketed under the trade name of Revolite

Plastics seldom seen

BY R. E. DODD*

A FLOOR-BRUSH manufacturer in an eastern city sees his business fall off steadily for years before he learns the reasons for the dissatisfaction. Kerosene, cleaning solutions and oils are attacking his bristle cement, and the bristles are falling out. He changes his setting technique to use resin cement and his business doubles. Customers lost for three years return to the fold with unusual enthusiasm.

A motor-car manufacturer hears complaints sifting back through dealers that his steering wheels blacken the hands and gloves. Coating seems the logical answer, but ordinary varnishes wear off rapidly and are affected by perspiration. He tries coating them with a thermosetting resin and the trouble is eliminated. The resin is smooth and lustrous, is proof against perspiration, and wears like iron.

What are these synthetic resins that figure so vitally in industrial processes and yet are so rarely seen? They are the underpinnings of the whole phenol-formaldehyde plastics industry: the pot of gold at the end of the research rainbow that was reached when men sought a substitute for shellac and ended up with a molding material. We've become so fascinated by the creation of a new structural element that we've almost forgotten the little lumps of amber-like gum that made it all possible.

These industrial processing resins have recently been re-classified into groups according to their form and use, thus clarifying and organizing this miscellany of solutions, powders, emulsions and colloids. Here is the new line-up:

1. Solid thermosetting resins
2. Impregnating solutions
3. Resin adhesives, cements
4. Coating solutions
5. Flexible resins
6. Impregnated paper, fabric
7. Resin emulsions, colloids
8. Water soluble resins
9. Liquid thermosetting resins
10. Oil soluble varnish resins

Peculiar properties can be found in these lumps of synthetic gum, not the least of which are their remarkable resistance to water, friction, wear, heat and chemical attack. Take brake linings, for instance. A few years ago city streets were filled with the screech and howl of automobile brakes. Add powdered thermosetting resin in the proper proportions and you eliminate the squeal and double or triple the lining's life. Brakes today are silent and smooth, and almost outwear the car.

Graphite motor brushes are another friction-application for this same type of resin, where it bonds the graphite particles into a tough stable unit. Similarly, use it to bond carbon particles in a radio resistor. Or abrasive particles in cutting or snagging wheels. It makes little difference what the particles are, whether cork or rubber or glass: if they must stay put despite heat and moisture, a phenol resin can probably do it.

In the old days, motor and generator armature windings used to be coated with oil varnishes, and at high speeds and overloading, the heat and centrifugal force would often burn and soften the film and cause throw-outs or shorts. An impregnating solution made of phenol resin steps in and contributes a mechanically stronger, higher dielectric and heat resistant winding. Coils that must stand moisture, chemicals or oils are similarly treated.

Impregnation

A metal casting has too great a porosity for, say, a high-compression application. Vacuum-pressure impregnates it with the same types of resin, cure it in ovens, and your trouble is over. Suppose corrosion or oxidation tends to start in those same pores in that same casting. The resin stops that too. It stops fungus growth in wood: besides, it seals out the moisture and prevents warping and cracking, gives it greater resistance to wear and impact, and can often combine this impregnation with attractive surface coating.

What holds incandescent light bulbs and radio tubes securely in their bases? Resin adhesives. What fastens molded plastic or composition parts together? Resin cement. What vulcanizes rubber sheets to metal? Those same resins. And they hold paint brush bristles in the metal ferrule despite pliers, solvents, water or age, and do it in a fraction of the time that it takes to vulcanize rubber.

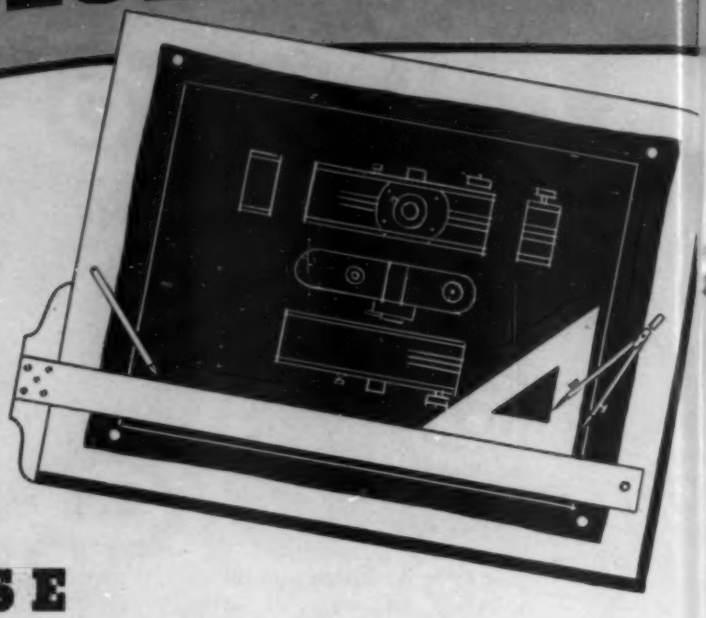
A large metal-plating firm was having trouble with the metal equipment parts used in its plating baths. The acids destroyed the parts almost completely. They tried coating them with phenol resins and they lasted three times as long. Rayon and textile equipment lasts longer when coated with similar resin solutions. There's a certain something in illuminating gas that attacks meter parts, but leaves a resin film untouched. Mirror backs are scratch-resistant after an application of this same resin. Shoe forms, cork floats, chemical equipment, and the wooden forms used in rubber balloon dipping are all longer-wearing, more resistant to acids, alkalies, solvents and water when resin coated. A cured resin film, by the way, is one of the hardest organic materials known to man. A cured resin film also is unaffected by repeated dousings in acetone.

Flexible resins

Tarpaulins and water-proofed fabrics often develop brittleness after a few months or years. Flexible resins can be used for this water-proofing—flexible enough to permit sharp creasing of the fabric without fracture, and maintaining their flexibility for years. Use the same resin for bonding abrasive particles to resin-treated paper and you have water-proof, heat-proof, non-softening, flexible sandpaper. Woven impregnated types of clutch facings and brake linings wear longer and more evenly when (*Continued on page 310*)

*Technical Sales Division, General Plastics, Inc.

CONVERTING BLUEPRINTS



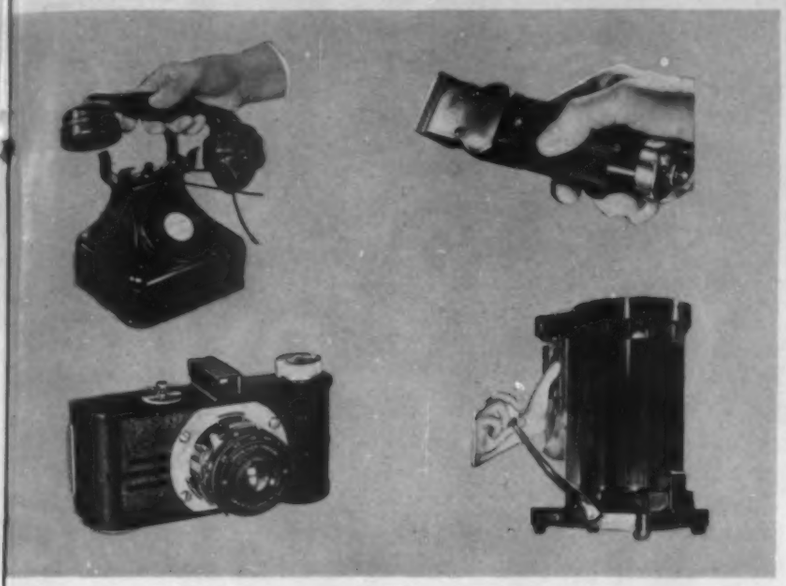
Durez improves on older, conventional raw materials... makes formerly impossible products *possible*... makes new, revolutionary designs practicable. More and more manufacturers are creating new products, redesigning old ones and establishing new sales records by capitalizing on the many advantages possible with Durez.

BECAUSE

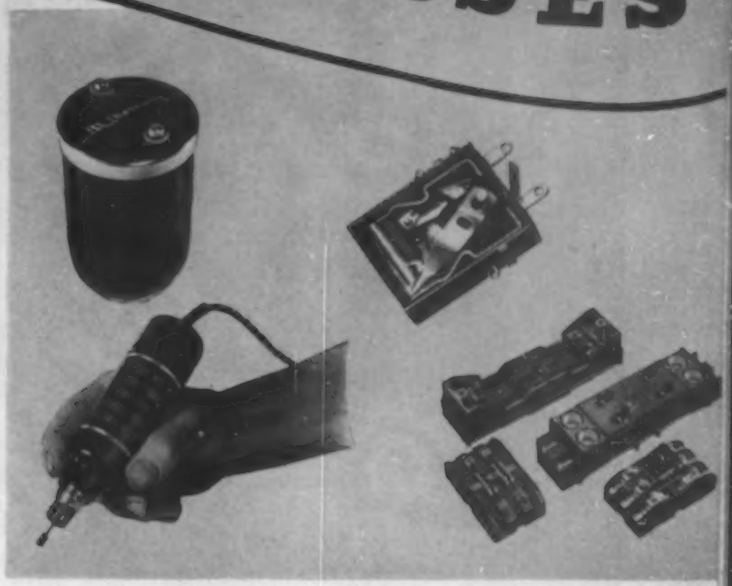
DUREZ HAS UNLIMITED DESIGN POSSIBILITIES. A modern radio, made of Durez, and embodying a brand new idea in construction and design, scooped the industry. A cosmetic jar in three colors—made in three pieces, 60% lighter than conventional jars, yet practically unbreakable—is another Durez scoop. Durez offers almost unlimited sculptural possibilities for housings, novelties and distinctive packages. Grooves, ribs, threads, decorative details... even directions for use and other data, can be molded as integral parts of Durez products.

DUREZ HAS A PERMANENTLY SLEEK AND COLORFUL SURFACE FINISH. Countless packages owe their rich "quality" appearance to Durez. Door knobs, closures, trays and housings are made of Durez because no amount of handling or abuse can make them chip, crack or dull. Durez is specified in many industrial applications because steam, caustics, solvents, mild acids and alkalis cannot pit or bleed the surface. Products made of Durez will never warp or peel, the finish can never wear off, because it goes all the way through... is not just applied.

INTO SALES SUCCESSES



DUREZ IS STRONG AND DURABLE, YET LIGHT IN WEIGHT. Look at your telephone...lift it, then just *try* to break it. Durez instrument cases are used for airplanes—and each of the four mounting lugs must withstand a breaking-pull test of 175 pounds. Heater housings, binoculars, chair arms and cameras are molded of Durez. Properly designed Durez cases and housings are unbelievably strong for their weight.



DUREZ HAS GREAT DIELECTRIC STRENGTH. (Up to 1000 volts per mil.) Wires and connections can be molded right in the housing, Durez itself supplying necessary insulation. Electrical parts made with Durez have good arc resistance, and can be used for high-tension ignition service. Distributor heads, motor housings, sockets, switchboards and push buttons are made of Durez.

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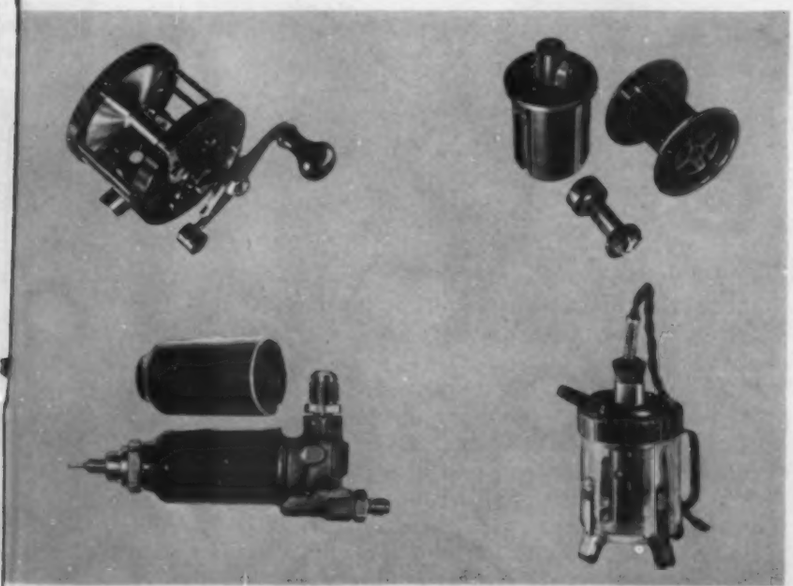


DUREZ IS INERT TO CHEMICALS, IS UNAFFECTED BY WATER, HEAT AND STEAM. The rayon industry uses Durez to make spools, frames and a host of other parts that must be chemically inert. Marine hardware, electrical fittings and fishing-reel housings are made of Durez to withstand the corrosive action of salt water. Durez is the only plastic that could remain immersed in the boiling, medicinal fluids of this vaporizer.

DUREZ IS FORMED AND FINISHED IN ONE OPERATION. Durez products come out of the mold complete with lugs, inserts, flutes, trade-marks, decorations and the final surface finish. Only slight buffing to remove fins is required. Durez products vary in size from a vest-pocket pillbox to the huge case of a complicated statistical machine. They are simple as a cap for a toothpaste tube, complex as an entire camera, complete except for shutter and lens.

It is the function of the Durez organization to assist manufacturers in determining the practical application of Durez molding compounds to their products. For further data consult your custom molder or write to us for descriptive literature and the advice of our technical staff. General Plastics, Inc., 710 Walck Road, North Tonawanda, N. Y.

Free on request, complete booklet of the many applications, uses and properties of Durez molding compounds.

DUREZ

MOLDING COMPOUNDS

SEE DUREZ ADVERTISEMENT ON PAGES — 54-55

Spraying the body of an automobile with a quick drying finish. This method makes it possible to finish a car in hours, whereas under the old method it required weeks

Resinous paint for industry

BY E. H. CAUSEY*

DURING the past decade or so the chemist has completely changed the former existing order in the use of finishing materials in virtually every line of business. Prior to that time paints and varnishes were just paints and varnishes and were produced by each manufacturer along conventional lines; that is, linseed oil and natural gum and later Chinawood oil, which was introduced about 1900, were the essential ingredients in all paints.

About 1927 an exhaustive investigation conducted by a well-known manufacturer of finishes demonstrated that the paint field was a highly competitive one due to the number of manufacturers engaged in it and, furthermore, that there was just so much business to be split up among them. This situation forced the conclusion that any considerable expansion of the market for finishes must result from the development of something not only new but revolutionary in character.

A few years prior, this company had developed a pyroxylin finish for automobiles which had completely revolutionized the finishing of cars. Instead of the old method of applying finishes to a car, coat over coat with a brush, the new finish is applied by spraying and the finish of a car has become a matter of hours instead of weeks, due to its ease of application and its quick drying properties. As this finish and method of application was used successfully on automobiles, it soon developed that it could be used with the same success in industry generally.

The advent of this finish marked the first important step forward in the paint and varnish industry in a hundred years. The use of this finish spread through-

* E. I. du Pont de Nemours & Company, Inc.

out the world, but the manufacturer recognized that still another type of finish was required. Although the pyroxylin finish is an ideal material for use under closely controlled application conditions and on relatively smooth surfaces, many users, due to limitations of shop conditions, methods of applications, or type of construction, found it difficult to take advantage of it.

The resources of the company were, therefore, bent to find new and adequate finishes which might fill other important conditions. The many laboratories of the company, its paint farms, its methods of testing, and its research facilities were brought to bear on the subject. The research resulted in the presentation of a complete line of finishes which are different from anything previously in use or anything ever created, formerly, for industry. They are as much a revolution as the pyroxylin finishes and were deliberately sought after in order to fill the gap which existed in the field of paint use.

The research chemists of the company began first to examine every product which might fit into the picture. In doing so, they found many things of great value to industry. But first, they investigated a great many so-called synthetic resins used in the manufacture of paints and varnishes that had to be dissolved in or mixed with oils to make a suitable vehicle.

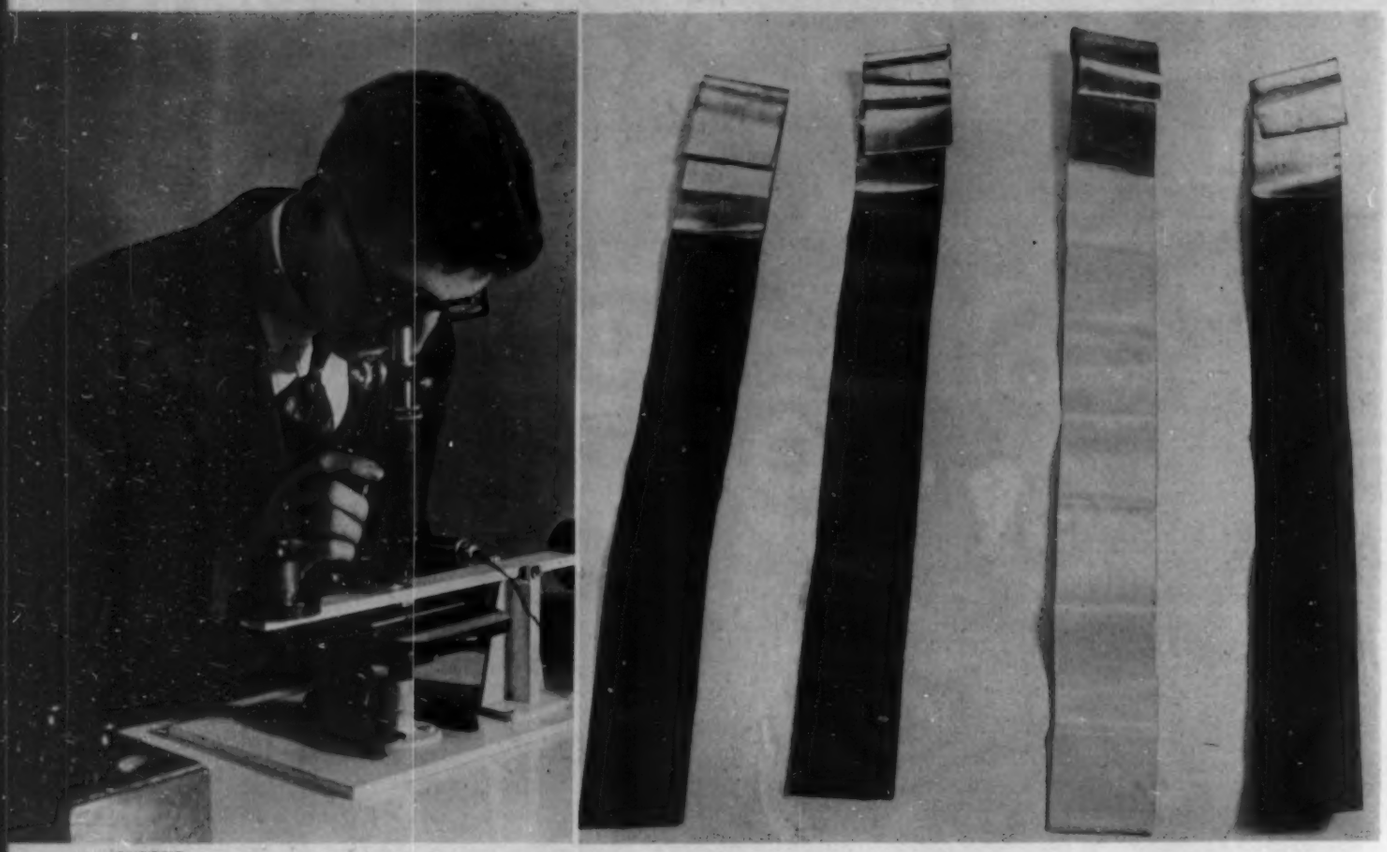
Distinct chemical compounds were sought which would contain within themselves all the qualities necessary for the finishing materials and would not have to be blended with oils before being used. It was realized that, if such a truly synthetic product could be found, it would likely have in a supreme degree the qualities of fast and hard drying and durability, and resistance to certain deteriorating effects found in various climatic conditions.

Many thousands of resinous substances were developed and tested during the years of preparation, from which a limited number were selected as having the most promising properties as vehicles for the new finish. Since those materials are chemical products, their properties depend upon methods and conditions of manufacture, as well as the materials used. Control of temperatures, speed of agitation, order of adding ingredients, time of reaction, type and amount of catalysts, all have important effects upon the finished product.

As a result of this extensive work, these chemists developed the synthetic glycerides. These are true synthetic products. When this synthetic material was

View of an "exposure" farm where thousands of panels are exposed for long periods in tests to determine durability and other properties of synthetic finishes

DUPONT



DUPONT

Left—A mechanical "finger nail" tests the hardness of finishing materials. No guess work here—but scientific fact finding. Right—Strips of tin coated with a synthetic finish and bent after two years' storage, were straightened, as shown, by drawing over the edge of a table. There is no sign of cracking or flaking

obtained it made possible durability, fast drying, toughness and retention of elasticity. But it also made possible a wide range of other physical properties which permit the production of various types of these finishes for specific purposes, without losing the qualities of durability and toughness.

The laboratory effort included the extremely important work on the so-called exposure farms. Few persons realize how extensive this exposure testing became in the search for such a new and revolutionary product. For instance, each step in the final selection of the various vehicles was preceded by many months of exposure tests to predetermine durability and other properties. Some idea of the scope of this work may be had when it is considered that 55,000 panels are under test now on these exposure farms. A staff of an appreciable number of men is required to maintain, examine and draw conclusions from these exposures.

A station in Florida gives an opportunity to see what will happen in an accelerated progress of corrosion resulting from the presence of electrolytes, such as salts, which might be present in the atmosphere along the sea coast. Others are located in industrial atmospheres in Chicago and Philadelphia, where atmospheric acids such as sulphur dioxide or hydrogen sulphide might be present, as generally they are present in industrial centers or thickly populated areas. The dry, thin atmosphere of Louviers, Colorado, was chosen for another exposure farm, as was also the dry Texas desert near Amarillo. Other farms are in Delaware, New Jersey and Michigan, so that the effects of the most diverse climatic conditions can be gauged in measuring the value of the finishes.

The work, both in the laboratory and field, was aimed to develop a complete system of finishes which would include a line of primers, intermediate and finishing coat materials in order to assure a maximum service value when used together. They will give outstanding results, also, when used as individual products, and may be used over previously primed or painted surfaces in satisfactory condition.

Although years of research and testing preceded the offering of these finishes, the real test of their service value is in their practical use. In the marine field, this synthetic resin base finish has been adopted as the standard finish by many large passenger and freight lines because of its protective value, better appearance, and practical economy. Like the pyroxylin finish, it is regarded as an outstanding finish in the automobile field, for new and refinished cars; for railway coaches, trolleys and busses; for commercial vehicles and trucks; for aircraft; for electric refrigerators and ice boxes; for electric ranges; for metal advertising signs, metal furniture and cabinets; for wood furniture, kitchen cabinets, etc.; gasoline stations and oil refinery maintenance painting; and for structural steel, and the general metal protective field, including steel bridges.

75,000,000 cutting tools a minute

BY DON MASSON*

The development of resinoid bonded abrasive wheels

Try to imagine a pile of seventy-five million cutting tools. Figures indicate that an average twenty-four inch abrasive wheel, four inches wide, has more than forty thousand abrasive particles on its grinding surface. The structure, with its 40,000 cutting points operating at a speed of 9,500 surface feet per minute, makes a total of 75,000,000 cutting points passing the work, not every day but *every minute*. That's a pretty busy wheel and the story behind its development is exceedingly interesting.

Modern grinding methods and machinery are altogether an American development. It all began with the making of sewing machines. It reached its present development with the manufacture of automobiles. When industry demanded speed, speed, and more speed in production, when, in addition, it demanded extreme accuracy and fine finish upon its hundreds of hardened surfaces, grinding became more important than ever. Grinding machines had to be better and grinding wheels had to grind faster.

In the middle of the last century, Joseph R. Brown was busy in New England with the manufacture of a sewing machine. As a way of finishing parts to exact measurements after hardening, he hit upon the expedient of fitting a lathe with an emery wheel instead of a cutting tool. The idea worked and in 1856 he started manufacturing and selling such a lathe. Later, Brown perfected a universal grinding machine which he exhibited in 1876. In the early machine, most of the fundamental principles of modern grinding machines are to be found.

Since that time, grinding equipment and grinding practice have extended into wider and wider fields of usefulness. Early development was mostly in the rough class of grinding. Machines for precision grinding came later. They are extensively employed today in the production of fine tools and of parts that must be economically finished into exacting measurements.

Man is forever making it his business to improve upon the materials that nature supplies. He made iron into steel, then into various alloy steels that today play such an important part in all manufacture. This same urge to be always improving is also evidenced in the history of abrasive wheels. The first wheels were made of natural stones. They were cumbersome and inefficient; they were not uniform; they did not have the range of usefulness that man needed for progress.

So man made his own wheels of emery, another abrasive supplied by nature. They were better, but the emery had many impurities that limited its usefulness.

* Technical Editor, Bakelite Corporation.

Resinoid-bonded snagging wheel—a strong, safe, fast-cutting wheel

High-speed resinoid frame grinder for surfacing castings

Man turned to corundum. Finally, he utilized the heat of the electric furnace to make his own abrasives to his own ideas and standards. Today, one or the other of two manufactured products, crystalline aluminum oxide and silicon carbide, supplies the abrasive in practically every grinding wheel in use.

But the abrasive—the material that does the grinding—is only one part of the wheel. It is in the wheel in the form of countless particles, each one a miniature cutting tool. Holding these particles together, holding all these cutting tools to their work is another substance called the bond. The bond is an important ingredient of the wheel—scarcely less important than the wheel itself. The bond holds the cutting particles until they have done their work. And in the bond, as in the abrasive, man has been busy seeking something better than nature could supply. Early experimenters in building grinding wheels used cement as a bond, but with little success. Such substances as vitreous clays, shellac, rubber, and silicate of soda were employed and are still in use.

The successful use of grinding wheels really began with the manufacture of wheels bonded with vitreous clays. Legend says that the first wheel of this kind was made on a bet. A brickmaker wagered that he could make a successful wheel combining an abrasive with clay and vitrifying it in his kiln. He won. After that, vitrified wheels came into general use. Then came the 1920's with their mammoth development of the automotive industry, their urgent demand for speed in production, their tireless search for the best, most economical way of doing (*Continued on page 310*)

3

5

4

3. High-speed floor stand grinding machine for snagging small castings. 4. Cut-off wheels for cutting rod and bar stock. 5. Cut-off wheels for cutting tubing in airplane construction.

(PHOTOS, COURTESY BAKELITE CORP.)

New Bakelite Products

ARE CONSTANTLY BEING DEVELOPED

Revolite Cloth, Luxene Resinoid Dentures, and Bakelite Cast Resinoid sheets, rods and tubes.

SINCE the development of Bakelite Molded and Bakelite Laminated, more than a quarter century ago, constant research in Bakelite laboratories has perfected other Bakelite materials of equal importance in their respective fields.

For example, Bakelite Cast Resinoid is used to an increasing extent today in the world of fashion, for packaging and decorative articles. Its durability and bright translucent colors ideally adapt it to containers, novelty jewelry, handles, and many other "style" items.

Another Bakelite product, Luxene Resinoid for Dentures, is rapidly establishing a place in prosthetic dentistry, because of its life-like appearance, and other unique merits.

In the paint and varnish industry, special Bakelite synthetic resins are contributing importantly to the setting of new high standards of durability for protective coatings.

Also included among recent outstanding Bakelite products are: Bakelite Resibond, a plywood bond of great strength and permanence; Revolite, a decorative fabric processed with a flexible Bakelite resinoid; B-R Boards and B-R Blanks from which machete handles, spools, radio and automotive parts, and countless other articles can be formed to advantage; and Bakelite cementop shingles.

Full information about any of these Bakelite products will be sent on request, and our engineers will gladly cooperate on specific applications.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N. Y.
BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin Street, Toronto, Ont.

BAKELITE

The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the capital "B" in the trade-mark sign for infinite, or unlimited quantity, it symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

THE MATERIAL OF A THOUSAND USES

75,000,000 cutting tools

(*Continued from page 308*) things rapidly and well.

An increase in the speed of grinding wheels was a means of accomplishing this end. Now, a wheel made with any material will burst when the centrifugal strains exceed the strength of the bonding agent. As far back as 1907 the inherent characteristics of resinoid had suggested to L. H. Baekeland that it could be employed as a strong bonding agent for abrasives. But there were three major problems involved: first, the development of resinoids that possessed the requisite properties for a satisfactory bonding material; second, an efficient practical method for manufacturing abrasive wheels with these resinoids; third, a wheel structure that would meet the many requirements of trade. Years of laboratory experimentation were required before satisfactory materials and processing for the making of resinoid bonded abrasive wheels were perfected and came into general use.

The first wheels were dense in structure. The modern high speed grinding wheels, bonded with phenolic resinoids,[1] have an open or porous structure, and were not generally available to industry until about 1925. The superiority of these wheels was immediately recognized, and from that time on their commercial importance rapidly increased. One of the most important strides in the abrasive industry was the introduction of these high speed wheels. Grinding wheels bonded with resinoids can be safely operated at higher speeds than other types of wheels, because the wheel structure is stronger. This permits marked production efficiency, because the rate of metal removal increases in proportion to the increase in operating speed.

In snagging castings and all rough grinding, the resinoid bonded wheels are operated at 9,500 surface feet per minute—an increase of more than 45 per cent in speed. Cut-off wheels are operated at 16,000 surface feet per minute—a speed of more than three miles per minute. These wheels are strong and fast. They are safe to operate at high speeds. They are porous and therefore run cool even in heavy service. They are adapted to almost every kind of grinding. Grinding cams of automobile cam shafts is a recent application of the new wheels. They are used for grinding valve stems; for sharpening or "gumming" saws; for forming and sharpening high-speed tools and cutters; for gears; for cutlery; for all types of disc grinding, including ends or seats of coiled springs used in the "knee" action on motor cars; for coping and molding marble and granite; for truing dresser wheels.

Visualize what the development of these high speed grinding wheels has meant to one industry. In 1905 it took five hours to turn and file the four pins of an automobile crankshaft. Today, grinding methods produce a better product in five minutes. Were it not for modern grinding processes, the cost of the average 1936 motor car would run into thousands of dollars. Thus, we find the plastics industry becoming increasingly important in another branch of industry—abrasives.

[1] Bakelite and Redmanol.

Plastics seldom seen

(*Continued from page 301*) impregnated with flexible resins, and industrial packings, leather articles, wire and mesh screens are similarly protected and strengthened by employing these resins.

Pass paper or fabric through a resin-bath, cut it and lay it in a short-draw molding die, and you have a tough, almost unbreakable piece. Or you can use this impregnated sheeting as a core for molding, or a reinforcing plate on a flat molded part. It won't flow like powder, but there are lots of short-draw molding applications for it. The same sheets can be used as a tough, inert, wear-proof surface for metal, rubber or composition sheets.

Using a water vehicle in which fine particles of resin are suspended is a unique processing method recently developed[1] for use where a thin layer of resin must be deposited on a surface. Bonding plywood, priming concrete surfaces, or priming and sizing wallboard and gypsum sheets are a few of the more important uses. Mix it with sand, form and bake it, and you have foundry sand cores of less porosity and no odors, gases or blows. Coating concrete tanks for chemical resistance is a typical application where the thin resin deposit is possible only with a water vehicle. Paper and fabrics are also coated—not impregnated—with these resin dispersions, and different colloids can be made either to air-dry or cure by heat as is desired.

Wooden knife handles, we all know, soak up water in time and split, warp, crack. There's a resin that goes into the pores and leaves enough on the surface to provide a smooth, chip-proof, resistant finish when baked. It's a type that can be diluted with water, and therefore soluble, and is used for impregnating wood or cellulose products which are most easily wet with water. Pulp toilet seats, brush backs, golf club heads, baseball bats, are all strengthened and hardened and surfaced by this type of phenolic material. Once cured, they are by no means soluble in water or other common solvents.

If you've done any varnishing or painting recently you've noticed how fast the film dries, how smoothly it levels, how glossy it is. Modern enamels will stand boiling in water all day and five to eight hours in a 5 per cent caustic, whereas a few years ago a varnish that withstood a quick spatter from a tea-kettle was considered phenomenal. Marine spars and industrial finishes now last two or three seasons instead of months. What does it? A few lumps of phenolic resin cooked into the oil and natural gums which make up a varnish or enamel vehicle.

These, then, are some of the better-known uses for these undramatic but versatile industrial phenomena —synthetic processing resins. They may have to concede the spotlight to their accidental offspring—the molding and casting resins—but their existence today is just as important, and their future just as bright.

[1] General Plastics Patent 1436820

Bibliography and Nomenclature

Selected bibliography of plastics

BY CARLETON ELLIS

The literature on plastics is very voluminous. A large number of articles are scattered throughout the chemical and technical journals for the last twenty-five years and a comprehensive list of these, including patents, would be out of the question. The number of books on the subject, however, is less formidable and an attempt has been made in the following to list these, as well as current magazines devoted to the subject. It is believed that in this way the whole literature is covered, at least indirectly.

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Nomenclature of plastics

BY CARLETON ELLIS

IN THE ramifications of the plastics industry many fields are touched upon. The binder is a resin or resinous composition which brings in chemistry, particularly colloid chemistry. Compounding the binder with fillers (if used) and auxiliaries is the next step. Planning appropriate molding equipment and properly molding the material to form a finished article is still another arena of specialized technique; and finally testing to see whether the product is fit for a particular use. Each step includes a separate art and nomenclature to cover the entire series must perforce be made up of terms taken from the individual fields. The following is a selected list of terms in glossary form designed to touch upon the whole.

Alkyd resin—Any condensation product involving a polybasic acid and a polyhydric alcohol. Typical examples are phthalic glyceride and its modifications containing combined fatty acids or rosin.

Aminoplast—General term for synthetic resins from amino or amido compounds. A typical example is urea-formaldehyde.

Amorphous—Devoid of crystalline structure.

Artificial rubber—Products possessing the physical properties of caoutchouc.

Asphalt—A dark-colored, viscous to solid hydrocarbon complex including: (a) the easily fusible bitumens often associated with a mineral matrix, not having a waxy luster or unctuous feel; (b) fusible residuums obtained from the distillation, oxidation, sulfurization, etc., of bitumens.

A-Stage resins—Thermosetting resins reacted only to the initial stage where they are soluble and fusible. The normal stage of a resin used for impregnation.

Balsams—Natural vegetable exudations consisting of resins mixed with volatile oil. The name is also applied to products having the physical characteristics of the natural balsams but produced by reactions which normally lead to resinous materials.

Bitumen—A naturally occurring or pyrogenous hydrocarbon complex insoluble in water but soluble in carbon disulfide. Color and hardness variable.

Bonding strength—The amount of adhesion between a binder and filler. More specifically, the measure of the extent to which the composite layers of a laminated product are bonded together.

Brittleness—Liability to break, generally to a conchoidal fracture.

B-Stage resins—Thermosetting resins reacted to a stage where they soften when heated and swell in contact with liquids but do not entirely fuse or dissolve. This is the preferred stage for the resin in molding compositions.

Bulk factor—The ratio by volume of the loose molding powder to the resultant finished article.

Casting—Forming a material into a shape by pouring it when liquid into a mold.

Cold flow—Change of dimensions or distortion caused by sustained application of a force greater than

the elastic limit. Cold flow is generally low with thermo-set products but is often appreciable and serious with thermoplastics.

Cold molding—A procedure in which a composition is shaped at ordinary temperatures and hardened by subsequent baking.

Colloid—Any substance when dispersed into particles whose size ranges between 5 and 100 millimicrons. Molecules of many synthetic resins fall within this range.

Compressive strength—Resistance to deformation under applied pressure.

Condensation—A chemical reaction in which two or more molecules combine with separation of water or some other simple substance. Applied to synthetic resins it means the formation of a resin by combination of a number of molecules with elimination of water, ammonia, hydrogen chloride or other simple substance. Examples of condensation resins are alkyd, phenol-aldehyde and urea-formaldehyde resins. The final products are also called condensation-polymers.

(See Polymerization)

Co-polymerization—The term applied when two or more substances polymerize at the same time to yield a product which is not a mixture of separate polymers but a complex having properties different from either polymer alone.

C-Stage resins—Thermosetting resins in the final stage in which they are infusible and insoluble. The state of the resin in the final molded article.

Curing—The change of a binder from the soluble-fusible condition to the substantially insoluble-infusible form by chemical action. The heat-setting of a resinoid. Action is analogous to vulcanization of rubber.

Densification—Any procedure applied to a molding powder to lower its bulk factor.

Dielectric strength—Voltage gradient at which a continuous electrical discharge will take place between two electrodes when the material in question is placed between the electrodes and a potential difference is applied to them.

Elastic—A substance which exhibits rubber-like properties or "high elasticity" over a wide range of applied forces.

Elastic deformation—When a substance reverts to its original dimensions on release of an applied stress.

Elastic limit—The point at which a body begins to yield under a stress; that is, when the stress is equal to or greater than the internal friction.

Elasticity—The property by virtue of which a body reverts to its normal bulk or shape after deformation by an applied force.

Eucolloids—Linear polymers of a degree of polymerization over 1000; that is, each molecule is made up of over 1000 units of a simple substance. They show pronounced swelling and their solutions are highly viscous. The solid eucolloids are very tough and hard.

Extrusion molding—A molding procedure for extended shapes of uniform cross-section, whereby a heat-softened substance is forced through an orifice of form coinciding with the cross-section of the article.

Filled products—Molding compositions or molded products containing fillers.

Flash mold—A mold designed to permit excess molding material to escape during final closing.

Flexibility—Capability of bending without breaking.

Flexural strength—Resistance of a substance to bending.

Fluidity—Reciprocal of the viscosity.

Gel—A somewhat rigid generally transparent, two-phase liquid-solid system in which the solid is precipitated as aggregates in and around which the liquid is held.

Gelation—Formation of a gel.

Gums—Viscous vegetable secretions which harden but, unlike resins, are water-soluble. The name is often applied, particularly in the varnish industry, to natural resins.

Hardness—Property of substances determined by their ability to abrade or indent one another.

Hemicolloids—Polymers of molecular weight up to 10,000, corresponding to an order of polymerization equal to 20 to 100 monometric units. They dissolve without swelling and give solutions of low viscosity. Precipitation from solution yields powdery masses.

Hot molding—The process of converting a composition into an article of desired size and shape by heat and pressure.

Impact strength—The measure of toughness of a material. Generally determined by the energy required to break a specimen in one blow.

Injection molding—A molding procedure whereby a heat-softened plastic material is forced from a receptacle into a cavity which gives the article of desired shape.

Inserts—Parts of a finished molded article which are of different material from the molding composition but are set in place or positioned by the molding operation.

Jelly—A material of soft homogeneous consistency usually transparent and quivering when shaken.

(See Gel)

Laminated products—Sheets of material united by a binder.

Lastic—A substance which at a certain temperature exhibits the physical properties of rubber. Unlike a viscous liquid, stress causes deformation at this temperature but removal of stress results in substantial recovery of the original shape.

Linear molecule—A molecule of highly elongated form. Generally applied to straight-chain polymers.

Loss factor—The product of the power factor and the dielectric constant.

Macromolecule—A molecule of such size that it exhibits colloidal properties.

Mesocolloids—Polymers intermediate between hemicolloids and eucolloids; that is, of a degree of polymerization between about 100 and 1000.

Modulus of elasticity—The stress required to produce a unit distortion.

Natural resins—Solid substances from vegetable excretions exhibiting brittleness, vitreous luster, conchoidal fracture, water-insolubility and varying fusibility.

Novolak—A permanently fusible and soluble phenol-aldehyde resin. More specifically it is the reaction product of 1 molecule of phenol with less than 1 molecule of formaldehyde, and an acid catalyst.

Phenoplast—A general term for phenol-aldehyde

resins. Synonymous with popular term "phenolics."

Pitch—A dark-colored, fusible, more or less viscous to solid bituminous or resinous substance, insoluble in water but more or less soluble in carbon disulfide, benzol, etc. Composition and origin variable.

Plastic flow—When flow is proportional to the pressure in excess of a certain minimum pressure (yield value) necessary to start the flow.

Plastics—All substances that can be molded. In general a plastic is a substance which behaves as a solid at stresses less than a certain amount known as the yield value and as a viscous liquid at stresses greater than this. The name is also applied to substances which originally but not ultimately fulfill this condition. For example, it is applied to thermoset compositions or resinoids in the final stages.

Plasticity—Susceptibility to and the retention of deformation. Capacity of taking and retaining the form of a mold. The property of solids by virtue of which they hold their shape permanently under the action of small shearing stresses but are readily deformed, worked or molded under larger stresses.

Polymerization—A chemical change resulting in the formation of a new compound whose molecular weight is a multiple of that of the original substance.

(*See Condensation*)

Positive mold—A mold designed to trap all the molding material to prevent its escape when it closes.

Potentially hardening—A term applied to resinoids, that is, to synthetic resins capable of passing into a C-stage.

Power factor—In an insulating material, the ratio of total power loss (watts) in the material to the product of voltage and current in a capacitor in which that material is a dielectric.

Preforms—Molding powders converted by pressure into a denser coherent form.

Resin—A term generally referring to a physical condition at room temperature approximating the physical properties of natural resins (q.v.). However, the temperature of reference should not be limited to room temperature and the term is here intended to embrace all substances which within a certain temperature range show these properties. For example, many oil-modified alkyd resins are viscous liquids at room temperature but not at lower temperatures; polystyrene is a resin at room temperature but rubber-like when warmed; rubber becomes brittle in liquid air.

Resinoids—The class name applied to thermosetting resins. Temporary thermoplastics.

Resite—A phenol-aldehyde resin in the C-stage (q.v.).

Resitol—A name often applied to a phenol-aldehyde resin in the B-stage (q.v.).

Resol—A name often applied to a potentially hardening phenol-aldehyde resin in the A-stage (q.v.).

Sol—A colloidal dispersion whose particles have sufficient Brownian motion to keep them in suspension.

Synlastic—A synthetic lastic (q.v.). Examples are Thiokol and DuPrene.

Synthetic resin—A complex, substantially amorphous, organic semi-solid or solid material (usually a mixture of substances) built up by chemical reaction of comparatively simple compounds and, depending upon the temperature at which the examination is made, approximating the natural resins in various physical properties: namely, luster, fracture, comparative brittleness, insolubility in water, fusibility or plasticity when heated or exposed to heat and pressure, and, at a certain more or less narrow temperature range before fusion, a degree of rubber-like extensibility; but commonly deviating widely from natural resins in chemical constitution and behavior with reagents.

Synthetic rubber—Caoutchouc synthesized in the laboratory. The term is a misnomer and most probably represents an impossibility.

Tars—Dark-colored substances, liquid or semi-liquid at room temperature often possessing a characteristic "tarry" odor, usually insoluble in water but soluble in carbon disulfide, benzol, etc., and which on distillation, oxidation, etc., form a pitch. Composition and origin variable.

Tensile strength—The sustained force required to break a piece of unit cross-section.

Thermoplastic—The property of softening under heat. All molding materials are thermoplastic at the initial application of heat. One class (the so-called thermoplastics) remains soft permanently under heat; the other (thermosetting), after first softening, sets or cures more or less quickly to a more solid form. A practical distinction is that with the first class the mold must be cooled before the molded article is removed, but not with the second. A thermoplastic substance is adequately rigid at normal temperatures and under ordinary conditions of stress but is capable of deformation under heat and pressure.

Thermosetting—The property of undergoing a chemical change when heated whereby a hardened product is obtained. Property most pronounced in phenol- and urea-formaldehyde resins and less so with alkyds. A thermosetting substance possesses initially the properties of a thermoplastic but under the influence of heat undergoes chemical change so that it is no longer thermoplastic but becomes permanently infusible.

Thixotropy—The property by which certain compositions become solid when at rest but liquefy again on agitation.

Transfer molding—Another name for injection molding (q.v.).

Treacle stage—A thermosetting neat resin in liquid form. Particularly applied to casting.

Urea resins—Thermosetting light-colored resins from urea and formaldehyde.

Vinyl resin—Thermoplastic derivatives of polyvinyl alcohol. Examples are Vinylite and Mowilith.

Viscosity—Internal friction or resistance to change of form of a liquid. The constant ratio of shearing stress to rate of shear.

Water-Absorption—Amount of water taken up when exposed to humid conditions or when immersed. Both rate of absorption and total absorption are important, also change in dimensions. A certain amount of absorbed water may improve mechanical properties but usually weakens electrical characteristics.

Yield value—The lowest pressure at which a plastic will flow. Below this pressure the plastic behaves as an elastic solid; above this pressure as a viscous liquid.

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Fortney Mfg. Co., Newark, N. J.
Gorham Company, Providence, R. I.
Highland Mfg. Co., Dayton, Ohio
Holmes Mfg. Co., Kenosha, Wis.
Jacob Loux & Sons Mfg. Co., Shaverstown, Pa.
Keller Mech. Eng. Corp., Brooklyn, N. Y.
Kuhn & Jacob Moulding & Tool Co., Trenton, N. J.
Leominster Tool Co., Leominster, Mass.
Mechanical Die & Tool Co., Brooklyn, N. Y.
Metropolitan Machine Works, Brooklyn, N. Y.
Newark Die Company, Newark, N. J.
Perfection Machine & Mfgrs. Works, Newark, N. J.
Roberts Mfg. Co., Inc., F. W., Lockport, N. Y.
Royal Tool Co., Bridgeport, Conn.
Smith Tool & Mfg. Co., R. G., Newark, N. J.
Standard Tool Co., Leominster, Mass.
Taft-Pierce Mfg. Co., Woonsocket, R. I.
Terkelsen Machine Co., Boston, Mass.
Viking Tool & Mach. Corp., Belleville, N. J.

MOLDS, CAST BERYLLIUM COPPER

Gorham Co., Providence, R. I.

PLATING OF MOLDS, CHROMIUM AND NICKEL

American Nickeloid Corp., Peru, Ill.
Apollo Metal Works, La Salle, Ill.
Associated Attleboro Mfrs., Inc., Attleboro, Mass.
Burr Chromium Co., Inc., Cambridge, Mass.
Industrial Plating & Finishing Co., Brooklyn, N. Y.

PRESSES, ARBOR

American Broach & Machine Co., Ann Arbor, Mich.
Atlas Press Co., Kalamazoo, Mich.
Baldwin-Southwark Corp., Philadelphia, Pa.
Barnes Co., W. F. & John, Rockford, Ill.
Bartlett Co., Edwin E., Nashua, N. H.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Elmes Engineering Works, Chas F., Chicago, Ill.
French Oil Mill Machinery Co., Piqua, Ohio
Hannifin Mfg. Co., Chicago, Ill.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Lake Erie Engineering Corp., Buffalo, N. Y.
Logansport Machine Co., Logansport, Ind.

PRESSES, CAKING

Baldwin-Southwark Corp., Philadelphia, Pa.
Burroughs Co., Newark, N. J.
Cavagnaro, John J., Harrison, N. J.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Loomis, Evarts G., Newark, N. J.

PRESSES, EMBOSSING

Baff Mfg. Co., No. Arlington, N. J.
Baldwin-Southwark Corp., Philadelphia, Pa.
Beck Machine Co., Chas., Philadelphia, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Burroughs Engineering Co., Newark, N. J.
Carver, Fred S., New York, N. Y.
Cavagnaro, John J., Harrison, N. J.
Chambersburg Engineering Co., Chambersburg, Pa.
Dunning & Boschert, Syracuse, N. Y.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Farrell Birmingham Co., Ansonia, Conn.
French Oil Mill Machinery Co., Piqua, Ohio
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Krehbiel Co., Inc., J. J., New York, N. Y.
Lake Erie Engineering Corp., Buffalo, N. Y.
Standard Machinery Co., Mystic, Conn.
Standard Tool Co., Leominster, Mass.
Terkelsen Machine Co., Boston, Mass.
Trand, Alex & Sons, Newark, N. J.
Watson-Stillman Co., Roselle, N. J.

PRESSES, EXTRUDING

Baldwin-Southwark Corp., Philadelphia, Pa.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Burroughs Engineering Corp., Newark, N. J.
Carver, Fred S., New York, N. Y.
Cavagnaro, John J., Harrison, N. J.
Dunning & Boschert, Syracuse, N. Y.
Elmes Engineering Corp., Chas. F., Chicago, Ill.
Farrel-Birmingham Co., Ansonia, Conn.
Farquhar Co., Ltd., A. B., York, Pa.
French Oil Mill Machinery Co., Piqua, Ohio
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Krehbiel Co., Inc., J. J., New York, N. Y.
Lake Erie Engineering Corp., Buffalo, N. Y.
Logemann Bros. Co., Milwaukee, Wis.
Watson-Stillman Co., Roselle, N. J.
Wood, R. D., Philadelphia, Pa.

PRESSES, HOBBING

Baldwin-Southwark Corp., Philadelphia, Pa.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Burroughs Engineering Co., Newark, N. J.
Elmes Engineering Works, Chas. F., Chicago, Ill.
French Oil Mill Machinery Co., Piqua, Ohio
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Keckley Co., O. C., Chicago, Ill.
Lake Erie Engineering Corp., Buffalo, N. Y.
Newark Die Co., Newark, N. J.
Watson-Stillman Co., Roselle, N. J.

PRESSES, HYDRAULIC

Baldwin-Southwark Corp., Philadelphia, Pa.
Bartlett Co., Edwin E., Nashua, N. H.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Burroughs Engineering Co., Newark, N. J.
Carver, Fred S., New York, N. Y.
Dunning & Boschert Press Co., Syracuse, N. Y.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Farquhar Co., Ltd., A. B., York, Pa.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
French Oil Mill Machinery Co., Piqua, Ohio
Hanifin Mfg. Co., Chicago, Ill.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Index Machinery Corp., Cincinnati, Ohio
Lake Erie Engineering Corp., Buffalo, N. Y.
Logemann Bros. Co., Milwaukee, Wis.
National Erie Co., Erie, Pa.
Standard Machinery Co., Mystic, Conn.
Terkelsen Machine Co., Boston, Mass.
Watson-Stillman Co., Roselle, N. J.
Wood Co., R. D., Philadelphia, Pa.

PRESSES, INLAYING

Ams Machine Co., Max, Bridgeport, Conn.
Baldwin-Southwark Corp., Philadelphia, Pa.
Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Cameron Can Machinery Co., Chicago, Ill.
Carver, Fred S., New York, N. Y.
French Oil Mill Machinery Co., Piqua, Ohio
Grimes & Harris, Inc., Leominster, Mass.
Henry & Wright Mfg. Co., Hartford, Conn.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Niagara Machine & Tool Works, Buffalo, N. Y.
Peck-Stow & Wilcox Co., Southington, Conn.
Standard Machinery Co., Providence, R. I.
Standard Tool Co., Leominster, Mass.
Waterbury-Farrel Foundry & Machine Co. Waterbury, Conn.

PRESSES, LABORATORY

Adamson Machine Co., Akron, Ohio
Baldwin-Southwark Corp., Philadelphia, Pa.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Burroughs Engineering Co., Newark, N. J.
Carver, Fred S., New York, N. Y.
Cavagnaro, John J., Harrison, N. J.
Colton Co., Arthur, Detroit, Mich.
Eimer & Amend, New York, N. Y.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Farrel-Birmingham Co., Ansonia, Conn.
French Oil Mill Machinery Co., Piqua, Ohio
Hyraulic Press Mfg. Co., Mount Gilead, Ohio
Index Machinery Corp., Cincinnati, Ohio
Krehbiel Co., Inc., J. J., New York, N. Y.
Lake Erie Engineering Corp., Buffalo, N. Y.
Patterson Foundry & Machine Co., E. Liverpool, Ohio
Stokes Machine Co., F. J., Philadelphia, Pa.
Terkelsen Machine Co., Boston, Mass.
Watson-Stillman Co., Roselle, N. J.

PRESSES, PREFORMING

Baldwin-Southwark Corp., Philadelphia, Pa.
Colton Company, Arthur, Detroit, Mich.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Kux-Lohner Machine Co., Chicago, Ill.
Standard Machinery Co., Mystic, Conn.
Stokes Machine Co., F. J., Philadelphia, Pa.

PRESSES, TOGGLE

Ams Machine Co., Max, Bridgeport, Conn.
Baff Mfg. Co., No. Arlington, N. J.
Bliss Co., E. W., Brooklyn, N. Y.
Dunning & Boschert Press Co., Syracuse, N. Y.
Engineering Laboratories, Inc., Paterson, N. J.
Hannigan Mfg. Co., Chicago, Ill.
Krehbiel Co., Inc., J. J., New York, N. Y.
Lake Erie Engineering Corp., Buffalo, N. Y.
Logemann Bros. Co., Milwaukee, Wis.
Niagara Machine & Tool Works, Buffalo, N. Y.
Standard Machinery Co., Mystic, Conn.
Standard Tool Co., Leominster, Mass.
Terkelsen Machine Co., Boston, Mass.
Toledo Machine & Tool Co., Toledo, Ohio
Waterbury-Farrel Foundry & Machine Co., Mystic, Conn.

PUMPS, HYDRAULIC

Aldrich Pump Co., Allentown, Pa.
American Engineering Co., Philadelphia, Pa.
American Steam Pump Co., Battle Creek, Mich.
American Well Works, Aurora, Ill.
Baldwin-Southwark Corp., Philadelphia, Pa.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burroughs Engineering Co., Newark, N. J.
Carbondale Machine Co., Carbondale, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
De Laval Steam Turbine Co., Trenton, N. J.
Dunning & Boschert Press Co., Syracuse, N. Y.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Erie Pump & Engine Works, Medina, N. Y.
Farquhar Co., Ltd., A. B., York, Pa.
French Oil Mill Machinery Co., Piqua, Ohio
Hydraulic Engineering Works, Chicago, Ill.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Index Machinery Corp., Cincinnati, Ohio
Ingersoll Rand Co., New York, N. Y.
Lake Erie Engineering Corp., Buffalo, N. Y.
Logemann Bros. Co., Milwaukee, Wis.
Union Steam Pump Co., Battle Creek, Mich.
Watson-Stillman Co., Roselle, N. J.
Wood & Co., R. D., Philadelphia, Pa.
Worthington Pump & Machinery Corp., Harrison, N. J.

PUMPS, VACUUM

Beechrus Co., Chicago, Ill.
Kinney Mfg. Co., Boston, Mass.
Lammert & Mann Co., Chicago, Ill.
National Scientific Corp., Chicago, Ill.
Stokes Machine Co., F. J., Philadelphia, Pa.

PYROMETERS

Bailey Meter Co., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Cambridge Instrument Co., Inc., New York, N. Y.
Engelhard, Inc., Chas., Newark, N. J.
Hoskins Mfg. Co., Detroit, Mich.
Illinois Testing Laboratories, Inc., Chicago, Ill.
Index Machinery Corp., Cincinnati, Ohio
Leeds & Northrup Co., Philadelphia, Pa.
Pyrometer Instrument Co., New York, N. Y.
Republic Flow Meters Co., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Co., Rochester, N. Y.
Wilson-Maeulen Pyrometer Co., Foxboro, Mass.

PYROXYLIN SCRAP

American Products Mfg. Co., New Orleans, La.
Atlantic Pyroxylin Waste Co., Arlington, N. J.
Celluloid Corp., New York, N. Y.
Eastman Kodak Co., Rochester, N. Y.
Gering, Inc., Larry, Newark, N. J.
Jefferys & Co., Ltd., Burbanic, Calif.
Limck, Green & Reed, Inc., Chicago, Ill.
Moses Sereinsky Co., Indianapolis, Ind.

SCREWS—HARDENED SELF TAPPING FOR PLASTIC PRODUCTS

Parker-Kalon Corp., New York, N. Y.

TOOL STEEL FOR HOBBED MOLDS, FOR MACHINED MOLDS, FOR HOBS

Carpenter Steel Co., Reading, Pa.
Crucible Steel Co. of America, New York, N. Y.
Jessop & Sons, Inc., Wm., New York, N. Y.
Ludlum Steel Co., Watervliet, N. Y.
McDonald & Co., P. F., Boston, Mass.
Republic Steel Corp., Cleveland, Ohio
Vanadium Alloy Steel Co., Latrobe, Pa.
Ziv Steel Co., Chicago, Ill.

DIRECTORY OF CUSTOM MOLDERS, FABRICATORS, DESIGNERS

AND OTHER SERVICES ESSENTIAL TO THE PRODUCTION OF FINISHED ARTICLES OF PLASTIC COMPOSITION MATERIALS

CUSTOM MOLDERS

Accurate Molding Corp., Brooklyn, N. Y.
Ackerman Rubber & Plastic Molding Co., Cleveland, Ohio
Alden Products Co., Brockton, Mass.
American Hard Rubber Co., New York, N. Y.
American Insulator Corp., New Freedom, Pa.
Armstrong Cork Co., Plastics Division, Lancaster, Pa.
Associated Attleboro Mfgrs., Inc., Attleboro, Mass.
Auburn Button Works, Inc., Auburn, N. Y.
Bay State Molding Co., Boston, Mass.
Berkander, Geo. F., Providence, R. I.
Boonton Molding Co., Boonton, N. J.
Boston Molded Products Co., Boston, Mass.
Breez Corp., Newark, N. J.
Bryant, Electric Co., Hemco Plastics Division, Bridgeport, Conn.
Butterfield, Inc., T. F., Naugatuck, Conn.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Celluloid Corp., New York, N. Y.
Chicago Molded Products Corp., Chicago, Ill.
Cincinnati Molding Co., Cincinnati, Ohio
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Consolidated Molded Products Corp., Scranton, Pa.
Cutler-Hammer, Inc., Milwaukee, Wis.
Davies Company, Harry, Chicago, Illinois
Dayton Insulating Molding Co., Dayton, Ohio
Diemolding Corp., Canastota, N. Y.
Eclipse Moulded Products Co., Milwaukee, Wis.
Economy Fuse & Mfg. Co., Chicago, Ill.
Erie Resistor Corp., Erie, Pa.
General Electric Co., Plastics Division, Bridgeport, Conn.
General Industries Co., Elyria, Ohio
General Insulate Co., Inc., Brooklyn, N. Y.
General Molding Co., Philadelphia, Pa.
General Products Corp., Union Springs, N. Y.
Gorham Company, Plastics Division, Providence, R. I.
Halen Mfg. Co., Ltd., Harry W., Los Angeles, Calif.
Hyde, A. L., Grenloch, N. J.
Imperial Molded Products Corp., Chicago, Ill.
Insulation Mfg. Co., Inc., Brooklyn, N. Y.
Kellogg Switchboard & Supply Co., Chicago, Ill.
Keystone Specialty Co., Cleveland, Ohio
Kuhn & Jacobs Moulding & Tool Co., Trenton, N. J.
Kurz-Kasch Company, Dayton, Ohio
Liberty Molding Works, Attleboro, Mass.
Los Angeles Molding Co., Los Angeles, Calif
Mack Molding Co., Inc., Wayne, N. J.
Mica, Inc., Mt. Vernon, N. Y.
Molded Insulation Co., Philadelphia, Pa.
Molding Corp. of America, Providence, R. I.
Niagara Insul-Bake Specialty Co., Inc., Albany, N. Y.
Northern Industrial Chemical Co., Boston, Mass.
Norton Laboratories, Inc., Lockport, N. Y.
Oris Mfg. Co., Inc., Thomaston, Conn.
Plano Molding & Mfg. Co., Plano, Ill.
Plastic Merchandisers, Inc., New York, N. Y.
Plastic Molding Co., Sandy Hook, Conn.
Plastic Molding Corp., Cincinnati, Ohio
Recto Molded Products, Inc., Cincinnati, Ohio
Remler Co., Ltd., San Francisco, Calif.
Reynolds Spring Co., Molded Plastics Division, Jackson, Mich.
Richardson Company, Cincinnati, Ohio
Royal Molding Co., Providence, R. I.
Seamless Rubber Co., New Haven, Conn.
Shaw Insulator Co., Irvington, N. J.
Specialty Insulation Co., Hoosick Falls, N. Y.
Stokes Rubber Co., Jos., Trenton, N. J.
Synthetic Molded Products, Inc., Stonington, Conn.
Tech-Art Plastics Co., Long Island City, N. Y.
Terkelsen Machine Co., Boston, Mass.
Trade Molding Co., Cleveland, Ohio
Union Insulating Co., Parkersburg, W. Va.
Universal Molding Co., San Francisco, Calif.
Waterbury Button Co., Waterbury, Conn.
Watertown Mfg. Co., Watertown, Conn.
Wheeling Stamping Co., Wheeling, W. Va.

DENTURES

Bakelite Corp., New York, N. Y.

DESIGNERS, INDUSTRIAL

Ackerman, Jay, Manning Bowman, 200 Fifth Ave., N. Y. C.
Adams, Wilbur Henry, 2341 Carnegie Ave., Cleveland, Ohio
Arens, Egmont, 480 Lexington Ave., N. Y. C.
Aronson, Joseph, 215 East 58th St., N. Y. C.
Bach, Alphonse, 724 Fifth Ave., N. Y. C.
Bach, Oscar, 305 East 46th St., N. Y. C.
Ball, George E., 250 Park Ave., N. Y. C.
Bel Geddes, Norman, 128 East 37th St., N. Y. C.
Blow, George, De Vaulchier and Blow, 103 Park Ave., N. Y. C.
Bernhard, Lucian, 120 East 86th St., N. Y. C.
Bouy, Jules, 125 East 46 St., N. Y. C.
Bureau, Achille G., 374 Burns St., Forest Hills, N. Y.
Cheron, Pierre, 65 Locust St., Stratford, Conn.
Colwell, Laurence J., 305 E. 63 St., N. Y. C.
Conant, Roger, 320 East 53 St., N. Y. C.
Dellert, Norman, 11 W. 42nd St., N. Y. C.
Deskey, Donald, 501 Madison Ave., N. Y. C.
De Vaulchier, Simon, De Vaulchier and Blow, 103 Park Ave., N. Y. C.
De Vries, Herman, 49 W. 45 St., N. Y. C.
Dreyfuss, Henry, 501 Madison Ave., N. Y. C.
Dryden, Helen, 25 Fifth Ave., N. Y. C.
Dulany, Helen Hughes, 936 Lake Shore Drive, Chicago, Ill.
Erwin, Hobe G., 15 East 57 St., N. Y. C.
Falconer, Richard E., 125 West 55 St., N. Y. C.
Farr, Fred, 311 Prospect Ave., Mamaroneck, N. Y.
Frankl, Paul, 509 Madison Ave., N. Y. C.
French, Carroll, 3 E. 51 St., N. Y. C.
Gaba, Lester, 237 E. 20 St., N. Y. C.
Gates, John M., 748 Fifth Ave., N. Y. C.
Gerth, Ruth K., 40 West 57 St., N. Y. C.
Gerth, William, 310 East 44 St., N. Y. C.
Graff, George, 386 Fourth Ave., N. Y. C.
Guild, Lurelle, 545 5th Ave., N. Y. C.
Hamil, Virginia, 6 East 45 St., N. Y. C.
Hornung, Clarence P., 23 West 47 St., N. Y. C.
Horwitt, Nathan George, 745 Fifth Ave., N. Y. C.
Jackson, Edwin, 175 East 60 St., N. Y. C.
Jensen, George, 169 W. 57 St., N. Y. C.
Jensen, Gustav, 288 Lexington Ave., N. Y. C.
Jiranek, Leo, 30 Rockefeller Plaza, N. Y. C.
Ketcham, Howard, 30 Rockefeller Plaza, N. Y. C.
Kiesler, Frederic, 56 Seventh Ave., N. Y. C.
Kogan, Belle, 185 Madison Ave., N. Y. C.
Kornloff, James, 39 E. 38 St., N. Y. C.
Kropp, Willis Ahlborn, Oak Park, Ill.
Lalique, Rene, 19 E. 47 St., N. Y. C.
Lauer, Caryl, 268 Lexington Ave., N. Y. C.
Lescaze, William, 211 E. 48 St., N. Y. C.
Linder, Laura Lee, Pittsfield, Mass.
Little, John, 101 Park Ave., N. Y. C.
Loewy, Raymond, 580 Fifth Ave., N. Y. C.
MacAlister, Paul, 30 Rockefeller Plaza, N. Y. C.
Miller, Frances T., 1 East 53 St., N. Y. C.
Muller, Theodore Carl, 30 Rockefeller Plaza, N. Y. C.
Muller-Munk, Peter, Carnegie Tech, Pittsburgh, Pa.
Nash, Ben, 30 Rockefeller Plaza, N. Y. C.
Parzinger, Tommi, 30 E. 23 St., N. Y. C.
Patmore, Derek, 146a E. 55 St., N. Y. C.
Petrucelli, Antonio, 444 East 58 St., N. Y. C.
Preis, Marion, 177 E. 87 St., N. Y. C.
Price, John C., 120 Fifth Ave., N. Y. C.
Reeves, Ruth, 84 University Place, N. Y. C.
Ressinger, Paul, Chicago, Ill.
Rideout, Jack, 520 Caxton Bldg., Cleveland, Ohio
Rohde, Gilbert, 136 E. 57 St., N. Y. C.
Root, John, 3728 Lowell Ave., Chicago, Ill.
Sakier, George, 40 W. 40 St., N. Y. C.
Sanders, Morris B., 219 E. 49 St., N. Y. C.
Scheele, Edwin H., 419 Fourth Ave., N. Y. C.
Simonson, Lee, 44 West 12th St., N. Y. C.
Slobodkin, Simon, 39 E. 23 St., N. Y. C.
Steiner, Malcolm, 14 West 40 St., N. Y. C.
Streng, Jan, 66 Fifth Ave., N. Y. C.

Swibold, Duane, 40 W. Milwaukee, Detroit, Mich.
Switzer, George, 336 Central Park W., N. Y. C.
Szabo, Bela, 607 W. 43 St., N. Y. C.
Teague, Walter Dorwin, 210 Madison Ave., N. Y. C.
Teegan, Otto, 5 East 57 St., N. Y. C.
Van Doren, Harold, 1217 Madison Ave., Toledo, Ohio
Vassos, John, Comstock Hill, Norwalk, Conn.
Versen, Kurt, 19 E. 47 St., N. Y. C.
Von Nessen, Walter, 211 E. 49 St., N. Y. C.
Weidhas, Ted, 538 W. 29 St., N. Y. C.
Wieselthier, Vally, 400 E. 57 St., N. Y. C.
Wilson, Scott, 342 Madison Ave., N. Y. C.
Wright, Russel, 165 E. 35 St., N. Y. C.

FABRICATORS, CASEIN

Aladdinite Corp., Orange, N. J.
American Plastics Corp., N. Y. C.
Baff Mfg. Co., No. Arlington, N. J.
Elite Jewelry Prod. Inc., N. Y. C.
Morrell, Geo., Muskegon, Mich.

FABRICATORS, CAST RESIN

Ace Mfg. Corp., Brooklyn, N. Y.
Apex Specialties Corp., Brooklyn, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Bauring Corp., Long Island City, N. Y.
Berkander, Geo. F., Providence, R. I.
Casca Products Corp., Bridgeport, Conn.
Chicago Button & Buckle Co., Chicago, Ill.
Colonial Kolonite Co., Chicago, Ill.
Colin & Rosenberger, Inc., N. Y. C.
Crest Mfg. Co., N. Y. C.
Ditglo Mfg. Co., Inc., New York, N. Y.
Elite Jewelry Prod. Inc., New York, N. Y.
Expert Celluloid Co., Inc., Long Island City, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Foster Grant Co., Inc., Leominster, Mass.
Gaess & Hollander, Astoria, Long Island, N. Y.
Goro Mfg. Co., New York, N. Y.
Hurst, Inc., Boston, Mass.
Industrial Plastics Co., New York, N. Y.
Ivory Craft Co., Long Island City, N. Y.
Keolyn Plastics Co., Chicago, Ill.
King Mfg. Co., J. M., Philadelphia, Pa.
Kirk Mfg. Co., Los Angeles, Calif.
Krest Mfg. Co., New York, N. Y.
Kreul Co., H., Detroit, Mich.
Lippincott, Geo. A., Philadelphia, Pa.
Marbelite Co., Wallingford, Conn.
Martin Art Co., Chicago, Ill.
Millers Falls Co., Greenfield, Mass.
Modern Plastics Sales Co., Philadelphia, Pa.
National Lock Co., Rockford, Ill.
Neomode Co., Lancaster, Pa.
New England Novelty Co., Leominster, Mass.
Ortho Plastic Co., New York, N. Y.
Philwin-Shaff, Inc., New York, N. Y.
Plastic Merchandisers, Inc., New York, N. Y.
Plastic Specialties, Inc., Brooklyn, N. Y.
Plastic Turning Co., Leominster, Mass.
Ply-Tex Mfg. Co., Brooklyn, N. Y.
Quality Turning Co., Leominster, Mass.
Roberts Mfg. Co., Providence, R. I.
Rogers Mfg. Co., Rockfall, Conn.
Scaefer Brass & Mfg. Co., St. Louis, Mo.
Seeberger, Fred B., Philadelphia, Pa.
Sohn Mfg. Co., T. M., Fremont, Ohio
Speidel Chain Corp., Providence, R. I.
Standard Rubber Co., New York, N. Y.
Sturdy Bros., Chartley, Mass.
Thermo-Plastic Laboratories, Inc., Wilkes-Barre, Pa.
Thomas Mfg. Co., Providence, R. I.
Turner Device, Inc., St. Louis, Mo.
Turner, Douglas, St. Louis, Mo.
Tyson, J. H., Wilkes-Barre, Pa.
Uncas Mfg. Co., Providence, R. I.
United Comb & Novelty Co., Leominster, Mass.
Voges Mfg. Co., Ozone Park, Long Island, N. Y.
Weil, Edgar, Philadelphia, Pa.

FABRICATORS, PYROXYLIN

Astorloid Mfg. Co., Inc., Brooklyn, N. Y.
Auburn Button Works, Inc., Auburn, N. Y.
Bachman Bros., Inc., Philadelphia, Pa.
Baff Mfg. Co., No. Arlington, N. J.
Banthico, Inc., Chicago, Illinois
Berkander, Geo. F., Providence, R. I.
Camillus Cutlery Co., New York, N. Y.
Celluloid Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Elite Jewelry Prod., Inc., New York, N. Y.
Elkloid Co., Providence, R. I.
Emeloid Co., Inc., Arlington, N. J.
Felsenthal & Sons, G., Chicago, Ill.
Fiberloid Corp., Indian Orchard, Mass.
Foster Grant Co., Inc., Leominster, Mass.
Gemloid Corp., New York, N. Y.
Gruver Mfg. Co., Chicago, Ill.
Hop Press, Inc., New York, N. Y.
Johnson Fare Box Co., Chicago, Ill.
Keolyn Plastics Co., Chicago, Ill.
Kippy Kit Co., Circleville, Ohio
Landers, Frary & Clark, New Britain, Conn.
Markilo Co., Chicago, Ill.
Mason & Company, Newark, N. J.
New England Novelty Co., Leominster, Mass.
New Haven Clock Co., New Haven, Conn.
Nixon Nitration Works, Nixon, N. J.
Parisian Novelty Corp., Chicago, Ill.
Plastic Turning Co., Leominster, Mass.
Quality Turning Co., Leominster, Mass.
Rebel & Frank, Inc., Cleveland, Ohio
Salz Bros., Inc., New York, N. Y.
Silverloid Co., Providence, R. I.
Van Aram Mfg. Co., Fort Wayne, Ind.
Wallstein Industrial Corp., Brooklyn, N. Y.
Williams & Marcus Co., Philadelphia, Pa.

LAMINATORS

Bakelite Rogers Co., Inc., Manchester, Conn.
Board, blanks and sheets containing synthetic resin.
Continental-Diamond Fibre Co., Newark, Del.
Sheets, rods, tubes and special shapes; rail joint insulation; refrigerator breaker strips; panels in natural wood grain finishes and marble effects; electrical insulation; fabricated fibre parts; silent gears.
Formica Insulation Company, Cincinnati, Ohio
Sheets, rods, tubes and fabricated parts; refrigerator breaker strips; decorative panels; gear blanks and gears, etc.
Franklin-Fibre-Lamitex Corp., No. Wilmington, Del.
Sheets, rods, tubes and fabricated parts.
General Electric Co., Plastics Division, Bridgeport, Conn.
Laminated sheets, rods, tubes and special forms.
General Laminated Products, Inc., New York, N. Y.
Textolite laminated material, Textolite molded parts.
Macarta Fabricators of Illinois, Chicago, Ill.
Mica Insulator Co., New York, N. Y.
Sheets, tubes, rods and fabricated parts; decorative materials; banded metal sheets; Panelyte sheets, rods, tubes and special shapes; gear stock panels, etc.
National Vulcanized Fibre Co., Wilmington, Del.
Standard forms of sheets, tubes and rods; machine stamped and fabricated shapes, such as panels, washers, bushings, etc.
Panelyte Corp., New York, N. Y.
Richardson Co., Cincinnati, Ohio
Sheets, rods, tubes, gear blanks; special punched and fabricated parts; refrigerator breaker strips, etc.
Spaulding Fibre Co., Inc., Tonawanda, N. Y.
Synthane Corp., Oaks, Pa.
Laminated products; sheets, rods, tubes, fabricated parts; bushings; gears; deals; insulation; screw machine parts; stabilized material.
Taylor & Company, Norristown, Pa.
Phenol Fibre sheets, rods, tubes and machined parts; Phenol Fabric laminated Bakelite and laminated Phenol Fibre sheets, rods, tubes, machined parts and gear blanks.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Sheets, rods, tubes and fabricated parts; refrigerator breaker strips; decorative panels; gear blanks and gears, etc.
Wilmington Fibre & Specialty Company, Wilmington, Del.
Sheets, rods and tubes.

MOLDERS, COLD

American Insulator Corp., New Freedom, Pa.
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Cutler-Hammer, Inc., Milwaukee, Wis.
Garfield Mfg. Co., Garfield, N. J.
General Electric Co., Plastics Division, Bridgeport, Conn.
Haveg Corp., Newark, Del.

MOLDING COMPOUNDS, CELLULOSE ACETATE

Celluloid Corp., New York, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Tennessee Eastman Corp., Kingsport, Tenn.

MOLDING COMPOUNDS, PHENOL FURFURAL

Stokes & Smith Co., Philadelphia, Pa.

MOLDING COMPOUNDS, PHENOL FORMALDEHYDE

Bakelite Corp., New York, N. Y.
Commercial Solvents, New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.
Makalot Corp., Boston, Mass.
Reilly Tar & Chemical Corp., Indianapolis Ind.
Resinox Corp., New York, N. Y.
Stokes & Smith Co., Philadelphia, Pa.

MOLDING COMPOUNDS STYRENE

U. S. Rubber Products, Inc., New York, N. Y.

MOLDING COMPOUNDS, UREA FORMALDEHYDE

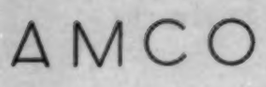
Beetle Products Division, American Cyanamid Co., New York, N. Y.
Plaskon Co., Inc., Toledo, Ohio
Resinous Products & Chemical Co., Philadelphia, Pa.

MOLDING COMPOUNDS, VINYL ACETATE

Carbide & Carbon Chemicals Corp., New York, N. Y.

MOLDER'S MARKINGS

Accurate Molding Co., Brooklyn, N. Y.



Accurate Molding Co., Brooklyn, N. Y.

Alden Products Corp., Brockton, Mass.

American Hard Rubber Co., Butler, N. J.

American Insulator Corp., New Freedom, Pa.

Consolidated Molded Products Corp., Scranton, Pa.

Arrow-Hart & Hegeman Electric Co., Hartford, Conn.

Kessbey & Mattison Co., Ambler, Pa.

Associated Attelboro Mfg., Inc., Attleboro, Mass.

Atwood & Orls Mfg. Co., Thomaston, Conn.

Auburn Button Works, Auburn, N. Y.

Geo. F. Berkander, Providence, R. I.

Boonton Molding Co., Boonton, N. J.

Bryant Electric Co., Bridgeport, Conn.

Cincinnati Molding Co., Cincinnati, Ohio

Chicago Molded Products Corp., Chicago, Ill.

Colt's Patent Firearms Co., Hartford, Conn.

Cutler-Hammer, Inc., Milwaukee, Wisconsin

Diemolding Corp., Canastota, N. Y.

The Emaloid Co., Inc., Arlington, N. J.

Garfield Mfg. Co., Garfield, N. J.

General Electric Co., Bridgeport, Conn.

H. J. Grigolait, Decatur, Ill.

General Industries Inc., Elyria, Ohio

Wm. Gullikson Machinery Co., Newton Lower Falls, Mass.

Harry W. Hahn Mfg. Co., Los Angeles, Calif.

Imperial Molded Products Co., Chicago, Ill.

Kellogg Switchboard and Supply Co., Chicago, Ill.

Kuhn and Jacobs Molding Co., Trenton, N. J.

The Kurz-Kasch Co. Dayton, Ohio

Mack Molding Co., Inc., Wayne, N. J.

McDonald Mfg. Co., Los Angeles, Calif.

Molded Insulation Co., Philadelphia, Pa.

Molding Corp. of America, Providence, R. I.

Moto-Meter Gauge and Equip. Co., Toledo, Ohio

Northern Industrial Chemical Co., S. Boston, Mass.

Bell Mfg. Co., Division of Northern Industrial Chemical Co., S. Boston, Mass.

Norton Laboratories, Lockport, N. Y.

Nagel Electric Co., Cincinnati, Ohio

Plastic Molding Corp., Cincinnati, Ohio

Recto Molded Products Co., Cincinnati, O.

Reynolds, Jackson, Mich.

Reynolds Spring Co., Jackson, Mich.

The Richardson Co., Melrose Park, Ill.

The Richardson Co., Melrose Park, Ill.

Royal Molding Co., Providence, R. I.

Shaw Insulator Co., Irvington, N. J.

Shaw Insulator Co., Irvington, N. J.

Specialty Insulation Mfg. Co., Hoosick Falls, N. Y.

Jos. Stokes Rubber Co., Trenton, N. J.

Synthetic Molded Products, Inc., Stonington, Conn.

Terkelsen Machine Co., Boston, Mass.

Union Insulating Co., Parkersburg, W. Va.

Universal Molding Co., San Francisco, Calif.

Waterbury Button Co., Waterbury, Conn.

Watertown Mfg. Co., Watertown, Conn.

Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Wheeling Stamping Co., Wheeling, W. Va.

DIRECTORY OF CHEMICALS AND RAW MATERIALS

USED IN THE MANUFACTURE OF PLASTIC COMPOSITIONS UTILIZED IN THE PRODUCTION OF MOLDED OR FABRICATED PARTS

ACETIC ANHYDRIDE

American-British Chemical Supplies, Inc., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Dow Chemical Co., Midland, Mich.
Mallinckrodt Chemical Works, St. Louis, Mo.

ACETONE

Baff Mfg. Co., No. Arlington, N. J.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Cliff Dow Chemical Co., Marquette, Mich.
Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Kessler Chemical Corp., Hoboken, N. J.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

ACETYLENE TETRA CHLORIDE

Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Innis, Speiden & Co., Inc., New York, N. Y.

ACID, ABIETIC

Glyco Products Co., Inc., New York, N. Y.
Hercules Powder Company, Wilmington Del.

ACID, ACETIC

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Monsanto Chemical Co., St. Louis, Mo.
Penn Salt Mfg. Co., Philadelphia, Pa.
Reilly Tar & Chemical Corp., Indianapolis, Ind.
Shawinigan Products Corp., New York, N. Y.
Tennessee Eastman Corp., Kingsport, Tenn.
Wishnick-Tumpeer, Inc., New York, N. Y.

ACID, BUTYRIC

Carbide & Carbon Chemicals Corp., New York, N. Y.
Innis, Speiden & Co., Inc., New York, N. Y.
Merck & Co., Inc., Rahway, N. J.

ACID, CRESYLIC

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
Barrett Company, New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Monsanto Chemical Co., St. Louis, Mo.
Reilly Tar & Chemical Corp., Indianapolis, Ind.

ACID, NITRIC

American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
General Chemical Co., New York, N. Y.
Hercules Powder Company, Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Rubber Products, Inc., Naugatuck Chemical Division, New York, N. Y.

ACID, SEBACIC

National Aniline & Chemical Company, Inc., New York, N. Y.
Resinous Products & Chemical Co., Inc., Philadelphia, Pa.

ACID, SULPHURIC

American Cyanamid & Chemical Corp., New York, N. Y.
Atlas Powder Company, Wilmington, Del.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Hercules Powder Company, Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Ind., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.

ALCOHOL

Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Hercules Powder Company, Wilmington, Del.
McKesson & Robbins, New York, N. Y.
Merrimac Chemical Company, Boston, Mass.
Monsanto Chemical Co., St. Louis, Mo.
Rossville Commercial Alcohol Co., New York, N. Y.
U. S. Industrial Alcohol Co., New York, N. Y.

ALCOHOL-AMYL

Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Kessler Chemical Corp., Hoboken, N. J.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
Sharples Solvents Corp., Philadelphia, Pa.
U. S. Industrial Chemical Co., New York, N. Y.

ALCOHOL-BENZYL

American-British Chemical Supplies, Inc., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.

ALCOHOL-BUTYL

Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Industrial Chemical Co., New York, N. Y.

ALCOHOL-DIACETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.

ALCOHOL-ETHYL

American Cyanamid & Chemical Corp., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
U. S. Industrial Alcohol Co., New York, N. Y.
U. S. Industrial Chemical Co., New York, N. Y.

ALCOHOL-ISOBUTYL

Carbide & Carbon Chemicals Corp., New York, N. Y.
Doe & Ingalls, Inc., Boston, Mass.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

ALCOHOL-ISOPROPYL

Advance Solvents & Chemical Corp., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Doe & Ingalls Inc., Boston, Mass.
Merck & Co., Inc., Rahway, N. J.

ALCOHOL-METHYL

Carbide & Carbon Chemicals Corp., New York, N. Y.

ALCOHOL-PROPYL

Carbide & Carbon Chemicals Corp., New York, N. Y.
Doe & Ingalls, Inc., Boston, Mass.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.

AMYL ACETATE

Baff Mfg. Co., No. Arlington, N. J.
Commercial Solvents Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
Sharples Solvents Corp., Philadelphia, Pa.
U. S. Industrial Chemical Co., New York, N. Y.

ANILINE DYES

American Aniline Products Inc., New York, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Calco Chemical Company, Inc., Bound Brook, N. J.
Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
General Dyestuff Corporation, New York, N. Y.
National Aniline & Chemical Co., Inc., New York, N. Y.
U. S. Rubber Products, Inc., Naugatuck Chemical Division, New York, N. Y.

ASBESTOS

Johns-Manville, New York, N. Y.
Keasby & Mattison, Ambler, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

ASPHALTUM

Barber Asphalt Co., Philadelphia, Pa.
Carey Co., Philip., Cincinnati, Ohio
Johns-Manville, New York, N. Y.
Wishnick-Tumpeer, Inc., New York, N. Y.

BENZALDEHYDE

Cliff Dow Chemical Co., Marquette, Mich.
Heyden Chemical Corp., New York, N. Y.

BENZOL

Barrett Co., New York, N. Y.
Harshaw Chemical Co., Cleveland, Ohio
Michigan Alkali Co., New York, N. Y.
Wishnick-Tumpeer, Inc., New York, N. Y.

BENZYL ACETATE

American-British Chemical Supplies, Inc., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

BENZYL BENZOATE

American-British Chemical Supplies, Inc., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

BUTYL ACETATE

American-British Chemical Supplies, Inc., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Industrial Chemical Co., New York, N. Y.

BUTYL ACETYL RICINOLEATE

Baker Caster Oil Co., Jersey City, N. J.
Commercial Solvents Corp., New York, N. Y.

BUTYL ETHER

Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.

BUTYL LACTATE

Commercial Solvents Corp., New York, N. Y.

BUTYL STEARATE

Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.

CADMIUM SULFIDE

American Smelting & Refining Co., New York, N. Y.
Chemical & Pigments Co., Inc., Baltimore, Md.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
General Metallic Oxides Co., Jersey City, N. J.
Harshaw Chemical Co., Cleveland, Ohio
Wishnick-Tumpeer, Inc., New York, N. Y.

CALCIUM STEARATE

American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Harshaw Chemical Co., Cleveland, Ohio
Mallinckrodt Chemical Works, St. Louis, Mo.
Wishnick-Tumpeer, Inc., New York, N. Y.

CAMPHOR

Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.

CARBON BISULFIDE

American Cyanamid & Chemical Corp., New York, N. Y.
Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Harshaw Chemical Co., Cleveland, Ohio
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

CARBON BLACK

Binney & Smith Co., New York, N. Y.
Cabot, Inc., Godfrey L., Boston, Mass.
Columbian Carbon Co., New York, N. Y.
United Carbon Co., Charleston, W. Va.
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

CARBON TETRACHLORIDE

American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Warner Chemical Co., New York, N. Y.
Wishnick-Tumpeer, Inc., New York, N. Y.

CASEIN

(Rods-Sheets-Tubes)

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
American Plastics Corp., New York, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Harshaw Chemical Co., Cleveland, Ohio
Hercules Powder Co., Wilmington, Del.
Innis, Speiden & Co., Inc., New York, N. Y.
Merck & Co., Inc., Rahway, N. J.

CELLULOSE ACETATE

(Rods-Sheets-Tubes)

American-British Chemical Supplies, Inc., New York, N. Y.
Celluloid Corp., New York, N. Y.
Cinelin Company, Indianapolis, Ind.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Company, Rochester, N. Y.
Fiberloid Corporation, Indian Orchard, Mass.
Gemloid Corporation, New York, N. Y.
Hercules Powder Company, Wilmington, Del.
Tennessee Eastman Corp., Kingsport, Tenn.

CELLULOSE NITRATE

(Rods-Sheets-Tubes)

American Cyanamid & Chemical Corp., New York, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Celluloid Corp., New York, N. Y.
Cinelin Company, Indianapolis, Ind.
Eastman Kodak Company, Rochester, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Gemloid Corporation, New York, N. Y.
Hercules Powder Company, Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Nixon Nitration Works, Nixon, N. J.
Sylvania Industrial Corp., New York, N. Y.

CHLORINATED RUBBER

Hercules Powder Co., Wilmington, Del.

COAL TAR COLORS

American Aniline Products, Inc., New York, N. Y.
Calco Chemical Company, Inc., Bound Brook, N. J.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

General Dyestuff Corporation, New York, N. Y.
National Aniline & Chemical Co., Inc., New York, N. Y.

COLORS AND PIGMENTS

American Aniline Products, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Binney & Smith Co., New York, N. Y.
Calco Chemical Co., Inc., Bound Brook, N. J.
Chemical & Pigments Co., Inc., Baltimore, Md.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
General Dyestuff Corporation, New York, N. Y.
Glyco Products Co., Inc., New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
Sherwin-Williams Co., Cleveland, Ohio
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

CRESOL

Barrett Co., New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
Reilly Tar & Chemical Corp., Indianapolis, Ind.

CROTONALDEHYDE

Carbide & Carbon Chemicals Corp., New York, N. Y.
Niacet Chemicals Corp., Niagara Falls, N. Y.

CYCLOHEXANOL

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.

DIAMYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
National Aniline & Chemical Co., Inc., New York, N. Y.
U. S. Industrial Chemical Co., New York, N. Y.

DIBUTYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
Monsanto Chemical Co., St. Louis, Mo.
National Aniline & Chemical Co., Inc., New York, N. Y.
U. S. Industrial Chemical Co., New York, N. Y.

DIBUTYL TARTRATE

American-British Chemical Supplies, Inc., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kay-Fries Chemicals, Inc., New York, N. Y.

DIETHYL PHTHALATE

Commercial Solvents Corp., New York, N. Y.
Kay-Fries Chemicals, Inc., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Industrial Chemical Co., New York, N. Y.

DIETHYLENE GLYCOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

DIMETHYL PHTHALATE

American-British Chemical Supplies, Inc., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kay-Fries Chemicals, Inc., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Industrial Chemical Co., New York, N. Y.

DIOXANE

Carbide & Carbon Chemicals Corp., New York, N. Y.

DRY COLORS

American Aniline Products, Inc., New York, N. Y.
Binney & Smith Co., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
General Dyestuff Corp., New York, N. Y.
Sherwin-Williams Co., Cleveland, Ohio
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

ESSENCE, PEARL

Amtorg Trading Corp., New York, N. Y.
Baff Mfg. Co., No. Arlington, N. J.
Celluloid Corp., New York, N. Y.

ETHYL ACETATE

Baff Mfg. Co., No. Arlington, N. J.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Kessler Chemical Corp., Hoboken, N. J.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
U. S. Industrial Chemical Co., New York, N. Y.

ETHYLALCOHOL—COMPLETELY DENATURED AND SPECIALLY DENATURED

American Cyanamid & Chemical Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
U. S. Industrial Alcohol Co., New York, N. Y.
U. S. Industrial Chemical Co., New York, N. Y.

ETHYL CELLULOSE

Hercules Powder Co., Wilmington, Del.

ETHYL FORMATE

Commercial Solvents Corp., New York, N. Y.

ETHYL LACTATE

American Cyanamid & Chemical Corp., New York, N. Y.
U. S. Industrial Chemical Co., New York, N. Y.

ETHYLENE DICHLORIDA

Carbide & Carbon Chemicals Corp., New York, N. Y.

ETHYLENE GLYCOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

FILLERS, ASBESTOS

Johns-Manville, New York, N. Y.

FILLERS, COTTON FLOCK

Claremont Waste Mfg Co., Claremont, N. H.

FILLERS, SILICA, DIATOMACEOUS

Johns-Manville, New York, N. Y.

FILLERS, WOOD, FLOUR

Becker, Moore & Co., Inc., North Tonawanda, N. Y.
Brown Co., Portland, Maine
Claremont Waste Mfg. Co., Claremont, N. H.
State Chemical Co., New York, N. Y.

FORMALDEHYDE

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Hercules Powder Co., Wilmington, Del.
Heyden Chemical Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

FUMARIC ACID

National Aniline & Chemical Co., New York, N. Y.

FURFURAL

Quaker Oats Co., Chicago, Ill.

HEXAMINE

American-British Chemical Supplies, Inc., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Heyden Chemical Corp., New York, N. Y.

HEXAMETHYLENETRAMINE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Heyden Chemical Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

IRON OXIDE—BLACK, BROWN, RED AND YELLOW

American Cyanamid & Chemical Corp., New York, N. Y.
Binney & Smith Co., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

KIESELGUHR

American Cyanamid & Chemical Corp., New York, N. Y.
Carey Co., Philip, Cincinnati, Ohio
Dicalite Company, New York, N. Y.
Johns-Manville, New York, N. Y.
Wishnick-Tumpeer, Inc., New York, N. Y.

LACQUER SOLVENTS

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
Bakelite Corp., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Monsanto Chemical Co., St. Louis, Mo.
Stanley Chemical Co., East Berlin, Conn.

LACQUERS—BAKING TYPE

Bakelite Corp., New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.

LACQUERS, NITROCELLULOSE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.
Egyptian Lacquer Mfg. Co., New York, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Hercules Powder Co., Wilmington, Del.
Maas & Waldstein Co., Newark, N. J.
Monsanto Chemical Co., St. Louis, Mo.
Pyroxylin Products Corp., Chicago, Ill.
Stanley Chemical Co., East Berlin, Conn.

LATEX (Liquid Rubber)

Heveatex Corp., Boston, Mass.
U. S. Rubber Products, Inc., New York, N. Y.

LIQUID RESINS

Bakelite Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.
Hercules Powder Co., Wilmington, Del.
Resinox Corp., New York, N. Y.

MALEIC ANHYDRIDE (Toxilic Anhydride Acid)

Monsanto Chemical Co., St. Louis, Mo.
National Aniline & Chemical Co., Inc., New York, N. Y.

METHANOL

Commercial Solvents Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
National Oil & Supply Co., Newark, N. J.

METHYL ACETATE

Advance Solvents & Chemical Co., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Ford Motor Co., Iron Mountain, Mich.

METHYL ACETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Tennessee Eastman Corp., Kingsport, Tenn.
U. S. Industrial Chemical Co., New York, N. Y.

METHYL AMYL ALCOHOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

METHYL HEXYL KETONE

Resinous Products & Chemical Co., Philadelphia, Pa.

METHYL ISOBUTYL KETONE

Carbide & Carbon Chemicals Corp., New York, N. Y.

METHYL METHACRYLATE

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Resinous Products & Chemical Co., Philadelphia, Pa.
Rohm & Haas Co., Philadelphia, Pa.

METHYLAMINES

Commercial Solvents Corp., New York, N. Y.
Rohm & Haas Co., Philadelphia, Pa.

MICA

American Cyanamid & Chemical Corp., New York, N. Y.
Harshaw Chemical Co., Cleveland, Ohio
Maryland Chemical Co., Baltimore, Md.
Wishnick-Tumpeer, Inc., New York, N. Y.

MINERAL BLACK

Binney & Smith Co., New York, N. Y.
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

MOLDING COMPOUNDS, CELLULOSE ACETATE

Celluloid Corp., New York, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Tennessee Eastman Corp., Kingsport, Tenn.

MOLDING COMPOUNDS, PHENOL FURFURAL

Stokes & Smith Co., Philadelphia, Pa.

MOLDING COMPOUNDS PHENOL FORMALDEHYDE

Bakelite Corp., New York, N. Y.
Durite Plastics, Div. of Stokes & Smith Co., Philadelphia, Pa.
General Plastics, Inc., North Tonawanda, N. Y.
Makalot Corp., Boston, Mass.
Reilly Tar & Chemical Corp., Indianapolis, Ind.
Resinox Corp., New York, N. Y.

MOLDING COMPOUNDS, STYRENE

U. S. Rubber Products, Inc., New York, N. Y.

MOLDING COMPOUNDS, UREA FORMALDEHYDE

Beetle Products Division of American Cyanamid Co., New York, N. Y.
Plaskon Co., Inc., Toledo, Ohio
Resinous Products & Chemical Co., Philadelphia, Pa.

MOLDING COMPOUNDS, VINYL ACETATE

Carbide & Carbon Chemicals Corp., New York, N. Y.

NAPHTHALENE

Barrett Company, New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Monsanto Chemical Co., St. Louis, Mo.
Reilly Tar & Chemical Corp., Indianapolis, Ind.

NITROCELLULOSE

American Cyanamid & Chemical Corp., New York, N. Y.
Atlas Powder Co., Wilmington, Del.
Baff Mfg. Co., No. Arlington, N. J.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Hercules Powder Company, Wilmington, Del.
Merrimac Chemical Co., Boston, Mass.
Sylvania Industrial Corp., New York, N. Y.
Zapon Co., Stamford, Conn.

OIL, SOYA BEAN

American Soya Products Corp., Evansville, Ind.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Staley Mfg. Co., A. E., Decatur, Ill.

PARAFORMALDEHYDE

American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Heyden Chemical Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

PHENOL

American Cyanamid & Chemical Corp., New York, N. Y.
Barrett Company, New York, N. Y.
Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Heyden Chemical Corp., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.
Reilly Tar & Chemical Corp., Indianapolis, Ind.

PHTHALIC ANHYDRIDE

American Cyanamid & Chemical Corp., New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
National Aniline & Chemical Co., Inc., New York, N. Y.

PLASTICIZERS

American-British Chemical Supplies, Inc., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Celluloid Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
Hercules Powder Co., Wilmington, Del.
Kessler Chemical Corp., Hoboken, N. J.
Monsanto Chemical Co., St. Louis, Mo.
National Aniline & Chemical Co., Inc., New York, N. Y.
Ohio-Apex, Inc., Nitro, W. Va.
Resinous Products & Chemical Co., Philadelphia, Pa.

RESIN BONDS FOR PLYWOODS AND VENEERS

Bakelite Corp., New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.
Resinous Products & Chemical Co., Philadelphia, Pa.

RESIN SOLUTIONS

Bakelite Corp., New York, N. Y.
Durite Plastics, Div. of Stokes & Smith Co., Philadelphia, Pa.
General Plastics, Inc., North Tonawanda, N. Y.
Makalot Corp., Boston, Mass.
Reilly Tar & Chemical Corp., Indianapolis, Ind.
Resinox Corp., New York, N. Y.

RESINS, CAST

American Catalin Corp., New York, N. Y.
Bakelite Corp., New York, N. Y.
Fiberloid Corp., Indian Orchard, Mass.
Marblette Corp., Long Island City, N. Y.
Rohm & Haas Co., Philadelphia, Pa.

RESINS, GLYCEROL

American Cyanamid & Chemical Corp., New York, N. Y.
Bakelite Corp., New York, N. Y.
General Electric Co., Plastics Division, Bridgeport, Conn.
Glyco Products Co., Inc., New York, N. Y.
Resinous Products & Chemical Co., Philadelphia, Pa.

RESINS, OIL SOLUBLE

Bakelite Corp., New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.
Makalot Corp., Boston, Mass.

RESINS, PHENOL

American Cyanamid & Chemical Corp., New York, N. Y.
Bakelite Corp., New York, N. Y.
Durite Plastics, Div. of Stokes & Smith Co., Philadelphia, Pa.
Fiberloid Corp., Indian Orchard, Mass.
General Plastics, Inc., North Tonawanda, N. Y.
Makalot Corp., Boston, Mass.
Reilly Tar & Chemical Corp., Indianapolis, Ind.
Resinous Products & Chemical Co., Philadelphia, Pa.
Resinox Corp., New York, N. Y.
Rohm & Haas Co., Philadelphia, Pa.

RESINS, SYNTHETIC
(See also Molding Compounds)

American Catalin Corp., New York, N. Y.
Bakelite Corp., New York, N. Y.
Beetle Products Division of American Cyanamid Co., New York, N. Y.
Carbide & Carbon Chemicals Corp., New York, N. Y.
Celluloid Corp., New York, N. Y.
Durite Plastics Div. of Stokes & Smith Co., Philadelphia, Pa.
Fiberloid Corp., Indian Orchard, Mass.
General Electric Co., Plastics Division, Bridgeport, Conn.
General Plastics, Inc., North Tonawanda, N. Y.
Glyco Products Co., Inc., New York, N. Y.
Goodyear Tire & Rubber Co., Akron, Ohio (Rubber Derivative)
Hercules Powder Company, Wilmington, Del.
Makalot Corp., Boston, Mass.
Marblette Corp., Long Island City, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
Plaskon Co., Inc., Toledo, Ohio
Reilly Tar & Chemical Corp., Indianapolis, Ind.
Resinous Products & Chemical Co., Philadelphia, Pa.
Resinox Corp., New York, N. Y.
Rohm & Haas Company, Philadelphia, Pa.
Shawinigan Products Corp., New York, N. Y.
Tennessee Eastman Corp., Kingsport, Tenn.
U. S. Rubber Products, Inc., Naugatuck Chemical Division, New York, N. Y.

RESINS, UREA

Bakelite Corp., New York, N. Y.
Beetle Products Division of American Cyanamid Co., New York, N. Y.
Glyco Products Co., Inc., New York, N. Y.
Plaskon Co., Inc., Toledo, Ohio
Resinous Products & Chemical Co., Philadelphia, Pa.

RESINS, VARNISH MAKING

Bakelite Corp., New York, N. Y.
Commercial Solvents Corp., New York, N. Y.
General Plastics, Inc., North Tonawanda, N. Y.
Hercules Powder Company, Wilmington, Del.
Makalot Corp., Boston, Mass.
Resinox Corp., New York, N. Y.

RESINS, VINYL ACETATE

Carbide & Carbon Chemicals Corp., New York, N. Y.

RESORCIN

du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Eastman Kodak Co., Rochester, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
National Aniline & Chemical Co., Inc., New York, N. Y.

ROSIN

Doe & Ingalls, Inc., Boston, Mass.
Hercules Powder Co., Wilmington, Del.

RUBBER, SYNTHETIC CRUDE

Thiokol Corp., Yardville, N. J.

TALC

American Cyanamid & Chemical Corp., New York, N. Y.
Baker Chemical Co., J. T., Phillipsburg, N. J.
Binney & Smith Co., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
International Pulp Co., New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Williams & Co., C. K., Easton, Pa.
Wishnick-Tumpeer, Inc., New York, N. Y.

TAR, COAL

Barrett Company, New York, N. Y.
Cabot, Inc., Samuel, Boston, Mass.
Cooper's Products Co., Pittsburgh, Pa.
Monsanto Chemical Co., St. Louis, Mo.
Reilly Tar & Chemical Corp., Indianapolis, Ind.

THIOUREA

American Cyanamid & Chemical Corp., New York, N. Y.
Doe & Ingalls, Inc., Boston, Mass.
Merck & Co., Inc., Rahway, N. J.
National Aniline & Chemical Co., Inc., New York, N. Y.

TOLUOL

American-British Chemical Supplies, Inc., New York, N. Y.
Barrett Company, New York, N. Y.
Calco Chemical Co., Inc., Bound Brook, N. J.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.
Monsanto Chemical Co., St. Louis, Mo.

TRIACETIN

American-British Chemical Supplies, Inc., New York, N. Y.
Doe & Ingalls, Inc., Boston, Mass.
Eastman Kodak Co., Rochester, N. Y.
Kessler Chemical Corp., Hoboken, N. J.

TRIETHYLENE GLYCOL

Carbide & Carbon Chemicals Corp., New York, N. Y.

UREA

Advance Solvents & Chemical Co., New York, N. Y.
American Cyanamid & Chemical Corp., New York, N. Y.
du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., Inc., Rahway, N. J.

VINYL, ACETATE

Carbide & Carbon Chemicals Corp., New York, N. Y.
Shawinigan Products Corp., New York, N. Y.

WOOD FLOUR

American Cyanamid & Chemical Corp., New York, N. Y.
Becker, Moore & Co., North Tonawanda, N. Y.
Composition Materials Co., Inc., New York, N. Y.
Doe & Ingalls, Inc., Boston, Mass.
Innis, Speiden & Co., Inc., New York, N. Y.
State Chemical Co., New York, N. Y.
Wishnick-Tumpeer, Inc., New York, N. Y.

DIRECTORY OF TRADE AND BRAND NAMES

MATERIALS AND ARTICLES PRODUCED IN PLASTICS

LEGEND

- **C** Casein
- **CA** Cellulose Acetate
- **G** Glycerol-phthalic Anhydride
- **PF** Phenol-formaldehyde
- **f** Fabricator's trade name
- **t** Material from which articles are made by machining
- **x** Material furnished in sheets, rods, tubes, from which articles are made by die-pressing, molding, machining, blowing
- **PX** Pyroxylin
- **SG** Safety glass
- **UF** Urea-formaldehyde
- **V** Viscose
- **l** Laminated
- **m** Molding compound

Name	Description	Manufacturer
Abalyn	Resin plasticizer	Hercules Powder Co., Wilmington, Del.
Ace-lte	Bitumen base	American Hard Rubber Co., New York, N. Y.
Acelloid	CA, m	General Plastics Corp., Ltd., London, SE 13
Acelose	CA, x	American Cellulose Co., Indianapolis, Ind.
Acetaloid	CA, m, x	Acetate Products Corp., Ltd., London, EC 4
Acetex	CASG	Acetex Safety Glass Co., Ltd., London, EC
Acetol	Cellulose acetate flake	Soc. Rhone-Poulenc, Paris
Acidur	Acid - resistant moldings	Cable Mfg. Co., Ltd., England
Acrolite	Phenol-glycerol m & l	Continental - Diamond Fibre Co., Bridgeport, Pa.
Acryseal	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Acryloid	Transparent sheets or molding	Resinous Products & Chemical Co., Philadelphia, Pa.
Acrysol	Resin	Rohm & Haas Company, Philadelphia, Pa.
Aerolite	Synthetic resin	S. Allcock & Co., Ltd., England
Agalyn	PX, denture	J. D. Whyte, Pittsburgh, Pa.
Agatine	PF, t	Soc. Nobel Francaise, London, EC 1
Akalit	C	Akalit Kunsthorn-Werke A. G., Wien
Alberit	PF, t	Chem. Fabr. Dr. Kurt Albert, Wiesbaden, Germany Scott, Bader & Co., Ltd., London, WC 2
Albertol	PF, m, x	Rohm & Haas Co., Philadelphia, Pa.
Albolit	PF, t	Augsburger Kunstharz-Fabrik, Augsburg, Germany
Alcolite	PX, denture	Alcolite, Inc., Philadelphia, Pa.
Aldydal	Synthetic resins	I. G. Farbenindustrie, Frankfurt, Germany
Alftalat	Resine	Kurt Albert G. m. b. H., Amöneburg, Germany
Alino	PX, f	R. Strauss, Frankfurt, Germany
Alvar	Vinyl resin	Shawinigan Chemicals Ltd., Montreal
Amberglow	PF, t	Laboratoires Industriels d' Asnières, Paris
Amberlac	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Amberol	Varnish resin	Resinous Products Co., Philadelphia, Pa.
Ambloid	C	Dai Nippon Celluloid Co., Ltd., Osaka, Japan
Ambrasit	PF, t	Chem. Fabr. Ambrasit, Wien
Ambroin	PF, etc.	Vereinigte Isolatorenwerke A. G. Wien
Ambroine	x	Soc. Grandgener, Perreux, France
Amerine		American Insulator Corp., New Freedom, Pa.
Amerith	PX, x	Celluloid Corp., New York, N. Y.
Amerloid	f	Amerloid Mfg. Co., Brooklyn, N. Y.
Ameroid	C	American Plastics Corp., New York, N. Y.
Apex	f	Apex Specialty Co., Brooklyn, N. Y.
Aqualite	l	National Vulcanized Fibre Co., Wilmington, Del.
Aquaplex	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Aquaresin	Water-soluble synthetic resin	Glyco Products Co., Brooklyn, N. Y.
Arcolite	PF,	Consolidated Molded Products Corp., Scranton, Pa.
Ardenite	Synthetic resin, m	F. G. Stokes, Ltd., Broadheath, Altrincham, England
Argolit	C	Argo Chem. & Nahrungsmittel Fabr., Prerov, Czechoslovakia
Armite	l	Spaulding Fibre Co., Inc., Tonawanda, N. Y.
Aroclor	Chlorinated diphenyl resins	Swann Chemical Co., Anniston, Ala.
Art y zan	PX, f	Celluloid Corp., New York, N. Y.
Astor	PX, f	Astorloid Mfg. Co., Brooklyn, N. Y.
Astrinite	Bitumen base	General Plastics Corp. Ltd., London, SE 13
Athrombit	PX, f	F. & M. Lautenschläger, G. m. b. H., München
Atlas	PF, l	H. Clarke & Co., Ltd. Manchester, England
Axolth **Axolithe**	C	Soc. Oyonnaxienne, Oyonnax, France
B-R Blanks	l	Bakelite-Rogers Co., Inc., Manchester, Conn.
B-R Board	l	Bakelite-Rogers Co., Inc., Manchester, Conn.
Bakeloque	PF, l	Attwater & Sons, Preston, England
Bakelit	PF, m, l, x, t	Bakelit Gesellschaft Germany
Bakelite	PF, m, l, x, t	Bakelite Corp., New York, N. Y. Bakelite, Ltd., London SW 1 Soc. della Bakelite, Ferrania, Italy
Beatl	UF, f	Beatl Sales, Ltd., London
Beetle	UF, m	Beetle Products Co., Ltd., Oldbury, Worcestershire, England
Beetleware	UF	Beetle Products Division of American Cyanamid Co., New York, N. Y.
Bellaphan	PX	Kalle & Co., A. G., Wiesbaden - Biebrich, Germany
Berkalin		Geo. F. Berkander, Providence, R. I.
Bernit	CA	Zelluloidwaren Fabr., Zollikofen, Switzerland
Bex **Bexite** **Bexoid**	PF, f f CA	British Xylonite Co. Ltd. London E 4
Bicella **Bicella-Glas**	Viscose-covered netting	Kalle & Co. A.-G., Wiesbaden-Biebrich, Germany
Bincolite	Molding compd. resorcinol	Allgem. Elektrizitäts Ges., Berlin
Bonnyware	PF, UF, f	Reynolds Spring Co., Jackson, Mich.
Boschbakelit	PF	Robert Bosch, Stuttgart, Germany
Breylite	Wood flour and binder	American Insulator Corp., New Freedom, Pa.
Bresin	Synthetic resin	Hercules Powder Co., Wilmington, Del.
Britmac	PF, C, f	C. H. Parsons, Ltd., Birmingham, England
Britsulite	PF, m	British Insulite, Ltd., Rochdale, Lancashire, England
Brofo	Coumarone resin	Brown & Forth, Ltd., London, NW 1
Butacete	PX, f	I. G. Farbenindustrie, Frankfurt
Campbellite	PF	Campbell Fibre Co., Stanton, Del.
Camphoroid	PX	Dai Nippon Celluloid Co., Ltd., Osaka, Japan
Carbolite	PF, m	Soc. Industrielle des Matieres Plastiques, Paris
Carta	PF, l	Isola Werke, A. G., Düren, Germany
Cascophane	PX, f	Cascelloid, Ltd., Leicester England
Casellithe	C	Soc. Industrielle du Celluloïde, Paris
Casolith	C	Hollandische Casolith-Werke L. M. Mears, London, EC 1
Catalin	PF, t	American Catalin Corp., New York, N. Y.
Cedelite	Molded insulation	Aciéries de Gennevilliers, Gennevilliers, France

Cégélite	PF, m	Cie. Générale d'Electricité, Paris
Celeron	PF, l	Continental Diamond Fibre Co., Newark, Del.
Celestol	Alkyd resin	F. A. Hughes & Co., Ltd., London, W 1
Cellanite	Laminated board	Micanite & Insulators Co., London, E 17
Celleste	PX	Verein für Chem. Industrie, A.-G., Frankfurt, Germany
Cellit	Cellulose acetate flake	I. G. Farbenindustrie, Frankfurt, Germany
Cellobase	PX, CA, V, f	Raymond Boisdé, Paris
Cellomold	CA, m	F. A. Hughes & Co. Ltd., London, W 1
Cellon	CA, x	Dynamit, A. G., Troisdorf, Germany
		F. A. Hughes & Co., Ltd., London, W 1
Cellosilber	PX, with metal coating	R. Kiefer, Dresden
Cell-o-Silver	PX, f	Gemloid Corporation, New York, N. Y.
Cellosit / **Cellosite**	CA, p	Ettore Rossi, Milan
Cellubutol	PX	I. G. Farbenindustrie, Germany
Celluln	CA, x, m	Paul Rie & Sohn, Praha, Czechoslovakia
Celluit	C	Soc. Industrielle du Celluloïde, Paris
Cellulak	l	Continental Diamond Fibre Co., Newark, Del.
Celluloid	PX, x	Celluloid Corp., New York, N. Y.
Celluverno	PX, x	Sillcocks Miller Co., South Orange, N. J.
Celtid	PX, x	Rheinische Gummi- & Celluloidfabrik, Mannheim-Neckerau, Germany
C-E 930	PF, m, dentures	Coe Laboratories, Inc., Chicago
Cetex	Cold molded	General Electric Co., Pittsfield, Mass.
Chermour	PX, f	Celluloid Corporation, New York, N. Y.
Cibe / **Cibonite**	UF, m / UF, m, t	Ges. für Chem. Industrie, Basel, Switzerland
Cinelin	PX, CA, refined film scrap	Cinelin Co., Indianapolis, Ind.
Ciro	PX, sound records	Celluloid Printers, Ltd., England
Clair de Lune	PX, f	Celluloid Corporation, New York, N. Y.
Cloisonnette	PX, f	Gemloid Corporation, New York, N. Y.
Clonaline	Resins	Soc. Résines et Vernis Artificiels, Lyons
Codite	l	Continental Diamond Fibre Co., Newark, Del.
Cogabi	PF, f	Cie. Gén. Belge d'Isolants, Bruxelles
Colistone / **Colbroch**	PF / Cold-molded	Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Compo-Site		Compo-Site, Inc., Newark, N. J.
Condensite	PF, m	Bakelite Corp., New York, N. Y.
Condulatum / **Conduline**		Mica Insulator Co., New York, N. Y.
Coronal	UF	Soc. l'Ambrolithe, Paris
Corozite	C	Soc. Anon. Prodotti Italiana Corozite, Gorlago, Italy
Cristolux	CA	Anciens Etablissements Bredet, Paris / Acetate Products Corp., Ltd., London, EC 4
Crystalate	Sound records	Crystalate Gramophone Record Mfg. Co., Tonbridge, England
Crystalite	Resin	Rohm & Haas Co., Philadelphia, Pa.
Crystallithe	Transp. resin	Léon Castany, Paris
Crystar	UF, t	Panplastics, Heyden Chem. Co., Garfield, N. J.
Cumar	Coumarone resin base	Barrett Co., New York, N. Y.
Cygnet	Resin, f	Edison Swan Electric Co., Ltd., London, EC 4
Deko-Ware	l	Harry Davies Co., Chicago, Ill.
Deko	m	Commercial Utilities, Ltd., London, EC 1
Demarda	PF, s	Bakelite, Ltd., London
Defiance	C	Jos. Nathen & Co., Ltd., London
Dekorit	PF, t	Dr. F. Raschig, G. m. b. H., Ludwigshafen, Germany
Dentegiene	f	Canadian Industries Ltd., Montreal
Dentolith	PX, denture	Korrespondenz - Blatt für Zahnarzte 57, Heft 3/4
Dever	m, t	Kreidl, Heller, & Co., Wien
Diafoam	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Diakon	Methyl Ester Molding Comp'd	Imperial Chemical Industries, Ltd., London
Dilecto / **Dilecto UF**	PF, l / UF, l	Continental Diamond Fibre Co., Newark, Del.
Dobsoid	C, f	John Dobson, Ltd., Milnthorpe, England
Dorcasine	C	Chas. Horner, Ltd., England
Dorex	PF	Soc. Dorex, Paris
Dulux	Resins, s	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. / Nobel Chem. Finishes Ltd., Slough, Bucks, England
Dumold	PX, m	E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Duoroware	f	Bryant Electric Co., Bridgeport, Conn.
Duosine	f	W. & G. Baird, Ltd., England
Duperite	f	Dunlop Perdriau Rubber Co., Melbourne
Duplate	SG	Duplate Corp., Pittsburgh, Pa.
Duprene	Synthetic rubber	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.
Duradent	Denture	Bakelite Dental Supplies, London, N 3
Duranoid	PF	Specialty Insulation Mfg. Co., Hoosick Falls, N. Y.
Duraplex	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Durax	PF, l	Isola-Werke, A. G., Düren, Germany
Durecol	G	Etabls. Kuhlmann, Paris
Durez	PF, m	General Plastics, Inc., North Tonawanda, N. Y.
Durite	PF, m, l	Stokes & Smith Co., Philadelphia, Pa.
Durium	Resorcinol-formaldehyde	Durium Products Corp., New York, N. Y.
Duroftal	Synthetic resin	Dr. Kurt Albert, G. m. b. H., Amöneburg, Germany
Duroid	PF	Soc. Bakelite, Paris
Durophene	PF, m, s	Scott, Bader & Co., Ltd., London, WC 2
Duroware	UF, f	Bryant Electric Co., Bridgeport, Conn.
Dux	Resins	Nobel Chemical Finishes, Slough, Bucks, England
Ebrok	PF, l	Richardson Company, Cincinnati, Ohio
Edelresonol	Synthetic resin	Resan Kunstharzfabrik A. G., Wien
Ekco / **Ekcozene**	m, f	E. K. Cole, Ltd., Southend-on-Sea, England
Elastica	SG, synthetic resin interlayer	I. G. Farbenindustrie, Frankfurt
Elbelit / **Elbenit** / **Elbolit**	Synthetic resins	L. Brüggemann, Heilbronn, Germany
Electrose	Hot molded	Insulator Mfg. Co., Brooklyn, N. Y.
Elephantide	l	Mica & Insulating Supplies Co., England
Elo	PF, m, s	Birkby's Liversedge, England
Enameloid	PX, f	Gemloid Corporation, New York, N. Y.
Epko	m	British Resin Products Ltd., Kingston, England
Ergolith	C	McLeod & McLeod, London, WC 1
Ericon	Decorative, PF, l.	Merritt Eng. & Sales Co., Lockport, N. Y.
Erinite / **Erinofort** / **Erinoid** / **Erinol** / **Erinoplas**	Resins / CA, x / C, x / Resin intermediates / m	Erinoid, Ltd., London, EC 2
Erinoid	C	American Plastics Corp., New York, N. Y.
Esterol	G	Paramet Chemical Co., New York, N. Y.
Esterpol	Synthetic resin	Glyco Products Co., Brooklyn, N. Y.
Exonite	PX	Dover, Ltd., Northampton, England
Fabroil	PF, l	General Electric Co., Plastics Dept., Bridgeport, Conn.
Fabrolite	PF, m	Commercial Utilities, Ltd., London, EC 1
Faturan	PF, t	Herold, A. G., Hamburg
Fiberlac / **Fiberloid** / **Fiberlon** / **Fibestos**	PX / PX, x / PF, t / CA, sheeting	Fiberloid Corp., Indian Orchard, Mass.
Firmoid	PN, CA, f	Bluemel Bros., Ltd., Wolston, England
Flexo	Resins	Glyco Products Co. Brooklyn, N. Y.
Formalite	PF	Bakelite, Ltd., London
Formapex Miocarta	l	Ioco Rubber & Waterproofing Co., Ltd., Glasgow
Formica	PF, l, UF, l	Formica Insulation Co., Cincinnati, Ohio
Formite	PF, t	Bakelite, Ltd., London
Formolit	m	Traun & Söhne, Hamburg
Formvar	Vinyl resin	Shawinigan Chemicals Ltd., Montreal
Furfural	Formaldehyde	Stokes & Smith, Philadelphia, Pa.
Futurit	PF	Kabelfabrik und Draht Industrie, Wien
Gala	C	Cie du Celluloïde-Petitcollin-Oyonnithe, Paris
Galakerite	C	Soc. Ital. Galakerite, Milano
Galalith / **Galapol**	C / Dip polish for C	Internationale Galalith Ges., Hoff & Cie, Harburg - Wilhelmsburg, Germany
Galatix	C, f	Lumos & Co., London, N 1
Gallie-Rubber	Ebonite plastic	Mfre. d'Isolants & Objets Moulés, Vitry - sur - Seine, France
Gédélite	Phenol, cresol-formaldehyde	Soc. Huiles, Goudrons et Dérivés, Paris
Gelva	Vinyl resin	Shawinigan Chemicals, Ltd., Montreal
Gemlike	PX, f	Gemloid Corporation. New York, N. Y.
Gemloid	PX, f	Gemloid Corporation New York, N. Y.
Gemstone	PF, t	A. Knoedler Co., Lancaster, Pa.
Gibralter	f	Baff Mfg. Co., Arlington, N. J.
Glorit / **Glorith**	C	Schiel & Co., Sternberg, Czechoslovakia
Glycolac	G	Etabls. Kuhlmann, Paris
Glyptal	G, t, s	General Electric Co., Schenectady, N. Y. / Etabls. Kuhlmann, Paris
Glyptanite	G & mica	Micanite & Insulators Co., Ltd., Walthamstow, England
Graflite	PF, f	Niagara Insul-Bak Specialty Co. Inc., Albany, N. Y.
H-Scale	PX, f	Celluloid Corporation, New York, N. Y.
Haefelyte	PF, t	Emil Haefely & Cie., Basel, Switzerland
Halex	f	British Xylonite Co., London, EC 4
Halowex	PF	Bakelite Corporation, New York, N. Y.
Hares / **Haresit** / **Haresit Platten** / **Harex**	PF, m, s / PF / PF, l / PF, l	Römmler, A. G., Spremberg, Germany
Harvite	m, f	Siemon Co., Bridgeport, Conn.
Haskelite	PF, l paneling	Haskelite Mfg. Corp., Chicago, Illinois
Haveg	PF, for chemical equipment	Haveg Corp., Newark, Del. / Säureschutz Ges., Berlin

Havegit	PF, t	Säureschutz Ges. Berlin
Hecolite / **Hekolith**	PX, denture	Heko-Werke, Berlin
Heleco	PX, f	H. Lehmann & Co., Frankfurt, Germany
Helius	C, f	A. & J. Lévy, Paris
Hemco-ware	UF, f	Bryant Electric Co., Bridgeport, Conn.
Hercolyn	Synthetic resin	Hercules Powder Co., Wilmington, Del.
Herkolite		General Electric Co., Plastics Dept., Bridgeport, Conn.
Herolith	PF, t	Herold, A. G., Hamburg
Heveatex	Rubber latex	Heveatex Corporation, Melrose, Mass.
Hi-Tensite	Rubber base	Tech-Art Plastics Co., Long Island City, N. Y.
Homac	Resin, m	Walton Chem. Co., Ltd., Liverpool
Hominit	Modeling Comp'd	Apotela, Ltd., Zürich Switzerland
Hycoloid	PX, CA, tubes bottles	Hygienic Tube & Container Co., Newark, N. J.
Hydrotex	I, f	Gatke Corp., Chicago, Ill.
Hyli	PX, f	Hygienische Industrie G. Ostertag, Ludwigsburg, Germany
Idelite	PF	Bakelite, Ltd., London
Imperlite	f	Imperial Molded Prod. Corp., Chicago, Illinois
Inda	C, x	American Machine & Foundry Co., Brooklyn, N. Y.
Inde-structo	SG	Indestructo Glass Corp., Farmingdale, N. Y. Belgian Indestructo Glass Co., S. A., Bruxelles British Indestructo Glass Co., London
Indur	PF	Reilly Tar & Chemical Corp. Indianapolis, Ind.
Indurite	PF, m	"Indurite" Sales, Ltd., London, SW 1
Infuselax	UF, s	Beetle Products Co., England
Insulate	Hot molded	Insulation Mfg. Co., Brooklyn, N. Y.
Insurok	PF, I	Richardson Co., Chicago, Illinois
Isoloid	CA	Charles Martin, Levallois, France
Isophan	Ethyl cellulose, p	Cellonwerke, Charlottenburg, Germany
Ivaleur	PF, t	Celluloid Corp., New York, N. Y.
Ivrite	PF	Soc. Anon., Ivra, Torino, Italy
Jarax	PF, I	Jaroslaw's erste Glimmerwaren Fabrik, Berlin-Weissensee
Jazolite	PF, f	Cie. Ind. de Mécanique Horlogerie, Paris
Karolith	C	American Plastics Corp., New York, N. Y.
Kelacoma	UF, m, f	Kelacoma, Ltd., Welwyn Garden City, England Soc. Nobel Francaise, Paris
Kellite	PF	Kellogg Switchboard & Supply Co., Chicago, Ill.
Kenoid	I	National Vulcanized Fibre Co., Wilmington, Del.
Kerit	C, f	Galalith, Ltd., London, EC 1 Int. Galalith-Ges., Hoff & Cie., Harburg - Wilhelmsburg, Germany
Korston	PF, t	Wedig & Reuss, Eilenburg, Germany
Kyloid	C	George Morrel, Muskegon, Michigan
Lacalite / **Lacalith** / **Lacaulite** / **Lacaulith**	Synthetic resins	Soc. d'Appl. des Goudrons & Dérivés, Paris
Lacanite	Shellac	Consolidated Molded Prod. Corp., Scranton, Pa.
Laccain	PF	Louis Blumer, Zwickau, Germany
Lacrinite	C, Pf, f	Lacrinoid, Ltd., London, E 7
Lactilitl.	C	Chas. Fitzroy, London, WC 1
Lactoid	C	British Xylonite Co., London, E 4
Lactolithe	C, x	Soc. Nobel Francaise, Paris & London, EC 1
Lactoloid	C	Dai Nippon Celluloid Co., Oseka, Japan
Lactonite	C, x	British Lactonite Co., London, EC 4
La France	f	Baff Mfg. Co., Arlington, N. J.
Lakilac	PF, m	Jos. Lucas, Ltd., Birmingham, England
La Lucille	f	Baff Mfg. Co., Arlington, N. J.
Lamicoid	I	Mica Insulator Co., Chicago, Ill.
Laminol	PF, I	Ellison Insulations, Ltd., Birmingham, England
Lasilac	m	Jos. Lucas, Ltd., Birmingham, England
Lewisol	Resins, s	John D. Lewis, Providence, R. I.
Lindol	PX, x	Celluloid Corp., New York, N. Y.
Linga-Longa	UF, f	Beatl Sales Co., London
Lithene	CA, m	Plastic Moulding Co., Ltd., London, N 16
Locron	UF, s	I. G. Farbenindustrie, Frankfurt
Lonarit	CA, m	Lonarit Ges., Berlin-Schöneberg
Lorival	PF, t,	Lorival Mfg. Co., Ltd., Southall, England
Lor-Wal-Lith	PF, t	J. M. S. G. m. b. H., Hamburg
Lotol	Processed latex	U. S. Rubber Products, Inc., New York, N. Y.
Lucite	PX, x	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.
Lugdomite	CA	Soc. Lyonnaise de Celluloide, Lyons, France
Lumarith	CA, m	Celluloid Corp., New York, N. Y.
Lusterloid		Sillcocks Miller Co., South Orange, N. J.
Luxene	Resin denture, PF	Bakelite Corp., New York, N. Y.
Makalot	PF, s, m	Makalot Corp., Boston, Mass.
Marblette	PF, t	Marblette Corp., Long Island City, N. Y.
Mastol / **Mastolite**	PF, s / PF, I	Symentis Products, Ltd., Eccles, England
Masuron	CA, m, x	J. W. Masury & Sons, Brooklyn, N. Y.
M. E. C.	CA, f	Minerva Eng. Co., London, SE 17
Micabond	I	Continental Diamond Fibre Co., Newark, Del.
Micarta	PF, I, UF, I	Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.
Micoid	I	Mica Insulator Company, New York, N. Y.
Micolite	PF, m	E. H. Kellogg & Co., Paris
Miconite	I	Mica Insulator Company, New York, N. Y.
ML	UF, f	Beatl Sales Co., London
Moldarta	PF, m, UF, m	Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.
Monolite	Hot molded	General Electric Co., Pittsfield, Mass.
Mouldensite	PF, m	Bakelite, Ltd., London
Mouldrite	PF, m	Croydon Mouldrite, Ltd., Croydon, England
Mowilith	Vinyl resins	I. G. Farbenindustrie, Frankfurt
Nacara	PX, x	Fiberloid Corp., Indian Orchard, Mass.
Negocol	Modeling Comp'd	Apotela, Ltd., Zürich, Switzerland
Neillite	m	Watertown Mfg. Co., Watertown, Conn.
Neolith	C	Deutsche Kunsthorn-Ges., Germany
Nestorite	PF, m, PF, s	Jas. Ferguson & Sons, Ltd., London, SW 19
Never-break	f	Baff Mfg. Co., Arlington, N. J.
Nixonoid	PX, x	Nixon Nitration Works, Nixon, N. J.
Nobeline	PF, t	Soc. Nobel Francaise, Paris
Nonflamm	f	Rheinische Gummi & Celluloidfabrik Mannheim, Germany
Norloc	f	Norton Labs. Co., Inc., Lockport, N. Y.
Novallic	PX,	K. F. Mayer, London, EC 1
Novite	PF, m	Imperial Chem. Industrie Ltd., London, SW 1
Novolak	PF, s	Bakelite Corp., New York, N. Y.
Novolithe	CA	Soc. Bellignite, Bellignat, France
Nusol	PF, f	Williams & Laird, Methil, Scotland
Oilsolate	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Olonite	CA, x	Soc. Ital. delle Celluloide, Castiglione Olona, Italy
Omegite	PF, m	British Dyestuffs Corp., Ltd., Manchester, England
Ondoine / **Ondolis**	PF, m / PF, m	Soc. Anon. Francaise du Ferodo, Paris
Orlak	PF, f	Chance Bros. & Co., West Smethwick, England
Oyocatil / **Oyogelithe**	CA / C	Soc. l'Oyonnaxienne, Oyonnax, France
Oyonnithe	C	Soc. Petit - Collin - Oyonnithe, France
Pancelyte	PX, CA, f	Pan Britannica Industries Ltd., London, SW 1
Panelyte	PF, I	Panelyte Co., Trenton, N. J.
Panolite		I. Paenson & Cie., Paris
Panplastic	PF, t	American Plastics Corp., New York, N. Y.
Pantolit	PF, t	Augsburger Kunstharzfabrik A. G., Augsburg, Germany
Paracoumarone	Coumarone and/or indene	Barret Company, New York, N. Y.
Paralac	G, resins	Imperial Chemical Industries, Ltd., London
Paranol	PF, s	Paramet Chem. Co., New York, N. Y.
Paraplex	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Paxolin	PF	Micanite & Insulators Co., Ltd., London, E 17
Permali	PF, s	Le Bois Bakelisé, Nancy France
Perspex	Methyl Ester Sheet form	Imperial Chemical Industries, Ltd., London
Pertinax / **Pertinit**	PF, I / UF, f	Meirowsky & Co., A. G., Porz am Rhein, Germany
Petrex	Resin	Hercules Powder Company, Wilmington, Del.
Phenac	Resin	American Cyanamid & Chemical Corp., New York, N. Y.
Phenoid	PF, I	Mica Mfg. Co., Ltd., England
Phenolite	PF, I, UF,	Natl. Vulcanized Fibre Co., Wilmington, Del.
Phobophene		Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.
Phoenixite	PX	N. V. Philips Gloeilampenfabrieken, Eindhoeven, Netherlands
Plaskon	UF, m	Plaskon Corp., Toledo, Ohio
Plass	UF, t	Pollopas Ltd., Nottingham, England
Plastacele	CA, x, m	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.
Plastine	CA, m	Soc. Nobel Francaise, Paris
Plasto	Synthetic resin	Advance Solvents & Chem. Co., New York, N. Y.
Plasti-o-cryx	Synthetic resin	Rex Campbell & Co., Ltd., England
Plastopal	UF, s	I. G. Farbenindustrie, Frankfurt
Plastose	PF	Afcom, Ltd., London, SW 9; Soc. la Plastose, Paris
Plexiger	Resin	Rohm & Haas Company, Philadelphia, Pa.
Plexigum / **Plexite**	Synthetic resin SG and interlayer	Rohm & Haas, Philadelphia, Pa.
Plioform	m, resin from rubber	Goodyear Tire & Rubber Co., Akron, Ohio
Pollopas	UF, m, t, I	Venditor, G. m. b. H., Troisdorf, Germany Pollopas, Ltd., London, EC 1 Etabls. Kuhlmann, Paris
Pontalite	Acrylic Resin	E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Prestellan	Synthetic resins	Allgem. Elektrizitäts Ges., Berlin

Primalithe	C, x	Cie Francaise Plinatus, Paris
Prizal	UF, t	Soc. Anon. des Matières Plastiques, Paris
Prizma		Mica Mfg. Co., Ltd., England
Probo	PFl,	L. Poulain, St.-Ouen, France
Protecto	PX,	Celluloid Corp., New York, N. Y.
Protectoid	CA	Celluloid Corp., New York, N. Y.
Prystal	PF	American Catalin Corp., New York, N. Y.
Prystaline	UF, m	Soc. Nobel Francaise, Paris
Pyradiolin	PX, x, slow-burning	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.
Pyraheel	PX sheeting for heel covering	
Pyralin	PX, x	
Pyroplax	Cold molded	Cutler-Hammer, Milwaukee, Wis.
Quakerlite		General Mouldings Co., Ltd., London, NW 1
Radion	f	Amer. Hard Rubber Co., New York, N. Y.
Ramos	PF, f	Universal El. Lamps Co., London, EC 2
Redmanol	PF, m	Bakelite Corp., New York, N. Y.
Reliance	PX, CA, f	Reliance, Ltd., Twickenham, England
Resan	PF	Bakelite Corp., New York, N. Y.
Resibond	PF	Bakelite Corp., New York, N. Y.
Resinit	PF	Knoll & Co., Ludwigshafen, Germany
Resinoid	f	Etabls. Durrschmidt, Lyon
Resinol	PF, s, m	Dr. F. Raschig, G. m. b. H., Ludwigshafen, Germany
Resinox	PF, m, s	Resinox Corp., New York, N. Y.
Resisto	PX, f	Celluloid Corp., New York, N. Y.
Resoglaz	Polystyrol	Advance Solvents & Chem. Co., New York, N. Y.
Resopal	UF	Rommler A.-G., Spremberg, Germany
Resovin	Vinyl resin denture	S. S. White Dental Mfg. Co., New York, N. Y.
Revolite	Cloth impreg. with PF	Revolite Corp., New Brunswick, N. J.
Reynolite	f	Reynolds Spring Co., Jackson, Mich.
Rezolite	PF	Cussons, Sons & Co., Manchester, England
Rezinal	Synthetic resins	Glyco Products Co., Brooklyn, N. Y.
Rezyl	G, s	American Cyanamid Co., New York, N. Y.
Richelein	UF, f	Richardson Co., Melrose Park, Ill.
Richware	PF	Makalot Corp., Boston, Mass.
Roanoid	UF, f	Roanoid, Ltd., Glasgow; Roanoid, Ltd., Melbourne
Rockite	PF, m, s	Rockhard Resins, Ltd., London, W 1
Rockshell	PF, m	
Ronilac	UF	For injection molding
Ronisol	PF	
Ronite	m	
Roxon	PF, f	Roxon, Ltd., London, EC 4
Rubtex	Hard rubber	Richardson Company, Cincinnati, Ohio
Runerit	PF, m, l	Elektro - Isolier - Industrie G. m. b. H., Wahn, Rheinland
Safety Samson	PX, f	Celluloid Corp., New York, N. Y.
Safetyware		Bryant Electric Co., Bridgeport, Conn.
Samson Celluloid	PX	Celluloid Corp., New York, N. Y.
Sani-Trete	f	Imperial Molded Prod. Corp., Chicago, Ill.
Sécurite	CA	Cie. du Celluloïde Petit-Collin-Oyonnithe, Paris
Sécubonite	Rubber & resin	Mfrs. d'Isolants & Objets Moulés, Vitry - sur - Seine, France
Sécucégélite	PF, m	
Shellware	f	General Mouldings Co., Ltd., London NW 1
Sicalite	C	Soc. Nobel Francaise, London, EC 1
Sicalite N		
Sicoid	CA	Soc. Ind. du Celluloïde, Paris
Simco	f	Sillcocks Miller Co., South Orange, N. J.
Similex	PF, t	Labs. Industriels d'Asnières, Paris
Similit	PF	
Similithe	C, f	Laguionie & Cie, Paris
Similoid	CA	Soc. Ind. des Matières Plastiques, Paris
Solidite	f	Solidite & Synthetic Mouldings, Ltd., London, SW 4
Solith	PF, t	Kunstharzfabrik Regal & Co., A. G., Praha
Spauldite	PF, l	Spaulding Fibre Co., Tonawanda, N. Y.
Stecol	Water-sol. resin	Glyco Products Co., Brooklyn, N. Y.
Starkware	f	Bryant Electric Co., Bridgeport, Conn.
Starlite	Synthetic resin	Soc. Gén. de Constr.-Electro - Mécanique, Limoges
Starpass	UF	
Stoco	Bituminous plastic	Jos. Stokes Rubber Co., Trenton, N. J.
Streetly	UF, f	Streetly Mfg. Co., Ltd., London
Superex	CA, m, denture	Alcolite, Inc., Philadelphia, Pa.
Super-micanite	Mica bonded with G	Superlithe Corp., New Brunswick, N. J.
Symentis	Plastic binder	Symentis Products Ltd., Salford, England
Synobel	Cements	Imperial Chemical Industries, Ltd., London, SW 1
Syn-phorm	Synthetic resin	Blackburn & Oliver, England
Syntheform	PF, f	Syntheform, Berlin
Synthane	PF, l	Synthane Corp., Oaks, Pa.
Syrolit	C	Aktiebolaget Syrolit, Eslöf, Sweden
Taumalit	PF, f	Isopresswerk, Berlin
Taylor	PF, l	Taylor & Co., Norristown, Pa.
Teglac	Synthetic resin, s	American Cyanamid Co., New York, N. Y.
Tego	Synthetic resin, s	Th. Goldschmidt, A. G., Essen, Ruhr
Tegofan	Chlorinated rubber	
Tegopren	Synthetic resin	
Tego Glue Film	PF (Adhesive)	Resinous Products & Chemical Co., Philadelphia, Pa.
Templus	f	Bryant Electric Co., Bridgeport, Conn.
Tenatext	PF, ragfilled, m	Allgem. Elektrizitäts Ges., Berlin
Tenazit	PF, m	
Tenite	CA, m	Tennessee Eastman Corp., Kingsport, Tenn.
Tepperite	Polystyrol denture	Martin Rubber Co., Long Island City, N. Y.
Textolite	PF, m, PF, l	General Electric Co., Plastics Dept., Bridgeport, Conn.
Thermoplax	Cold molded	Cutler-Hammer Mfg. Co., Milwaukee, Wis.
Thermose	Benzyl cellulose denture	Bakelite Dental Supplies, London
Thiokol	Olefine Polysulphide	Thiokol Corp., Yardville, N. J.
Thiolite	PF, treated with sulphur chloride	Soc. la Thiolite Joinville-le-Pont, France
Thyrite		General Electric Co., Plastics Dept., Bridgeport, Conn.
Tornesit	Chlorinated rubber	Hercules Powder Co., Wilmington, Del.
Totaloid	CA, f	Fiberloid Corp., Indian Orchard, Mass.
Trafoil	PF	Bakelite Ltd., London, SW 1
Trolit W	CA, m	Dynamit A. G., Troisdorf, Germany
Trolit Spritzgussmasse	CA, for injection molding	
Trolitan	PF, m	Venditor Kunststoff-Verkaufsges, m. b. H., Troisdorf, Germany
Trolitan-Profile	Continuous molded shapes	
Trolitan Z	PF, m in light colors	
Trolitax	PF, l	
Trolitul	Polystyrol m	
Tulnol	PF, l	Ellison Insulations, Ltd. Birmingham, England
Turbax	PF, l	Jaroslaw's erste Glimmer - Waren - Fabrik, Berlin - Weissensee
Turbonic	PF, ml	Jaroslaw's erste Glimmer - Waren - Fabrik, Berlin - Weissensee
Turbonit		
Uformite	Resin	Resinous Products & Chemical Co., Philadelphia, Pa.
Ultraphan	CA, p	Lonza Werke, Weil-am-Rhein, Germany
Ultrasit	PF, t	Ambrasit - Werke, G. m. b. H, Wien
Unyte	UF, m	Plaskon Corp., Toledo, Ohio
Uralite	UF, f	Consolidated Molded Prod. Corp., Scranton, Pa.
Urocristal	UF, m transparent	Fabriques de Laire, Issy, France
Urophane	UF, m transparent	Soc. Résines et Vernis Artificiels, Paris
Utilit	PF, t	Augsburger Kunstharz-Fabrik, Augsburg, Germany
Utilitape	Waterproof tape	Revolite Corp., New Brunswick, N. J.
Utiloid	CA, in powder form	James Hind, London, N 16
Varcrex	Synthetic resin	Rex Campbell & Co., Ltd., England
Velskin	Lampshade material	Albion Shades, Ltd., England
Venite	PX, f	Bluemel Bros., Ltd., Wolston, England
Veryx	UF	Edgard Israel, France
Victron	Polystyrol, m	U. S. Rubber Products, Inc., New York, N. Y.
Vigorit	PF, t	Dr. F. Raschig G. m. b. H., Ludwigshafen, Germany
Vinnapas	Vinyl resin	Consortium für Elektrochemische Industrie G. m. b. H., Germany
Vinsol	Synthetic resin, s	Hercules Powder Co. Wilmington, Del.
Vinylite	Vinyl resin, m	Carbide & Carbon Chem. Co., New York, N. Y.
Viscoloid	PX, x	E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.
Vitrolac	Sound records of vinyl resin	RCA-Victor Corp., Camden, N. J.
Vitrolux	Cellulosic panes	W. & G. Baird Ltd., England
Vulcabeston	PF, f	Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Vulcoid	PF, l using vulcanized fiber	Continental - Diamond Fibre Co., East Newark, Del.
Vulcot	l (fibre)	National Vulcanized Fibre Co., Wilmington, Del.
Vydon	Vinyl resin denture	Lee S. Smith & Son, Pittsburgh, Pa.
Wahnerit	PF, l	Elektro - Isolier - Industrie, m. b. H., Wahn, Germany
Wandite	PF	H. Wandrowsky, Berlin
Waterlite	Polystyrol	Watertown Mfg. Co. Watertown, N. Y.
Wemcore	m, l	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wenjazit	PF, t	Kunst-Rohstoff A. G., Hamburg
Xylonite	PX, x	British Xylonite Co., Ltd., London, E 4
Xylose	Benzyl cellulose denture	Bakelite Dental Supplies, London, N 3
Yunos	PF f	Universal Electric Lamp Co , London, EC 2